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JOURNAL

OF THE INSTITUTION OF ELECTRICAL ENGINEERS

VOLUME 3 (NEW SERIES) NUMBER 34 OCTOBER 1957

NOW IN FULL SWING

MANY MEMBERS WHO RECEIVED THE LONDON meetings card last month will by now have selected and noted the dates of those meetings that they hope to attend this session. For many others, living outside the London area but coming at times to London meetings, the programme given elsewhere in this issue will provide the first opportunity of appreciating the calendar of evening meetings at Savoy Place from mid-October to Christmas, the bulk of the period covering the first half of the session. For although some members in the Local Centres will have glanced at the interim programme printed in the September *Journal*, it has probably left little impression—September is still summer, and the new session is always some way off until it has started.

But now that the Presidential Address and at least two Section Chairmen's Addresses are already evening occasions to remember, rather than to anticipate, the session is indeed in full swing. One meeting follows hard on the heels of another, and he would be an engineer of unusually specialized taste who could not find something to tickle his palate on the menu now unfolded for his inspection.

The natural sequels to the President's Address are the four Addresses of the Chairmen of the Specialized Sections, and these have not yet all been delivered. But some dipping into the advance scripts confirms that their content is as erudite and stimulating as in past years. This year our prize for titles must surely be divided between the Chairmen of the two 'heavy' Sections. 'Joints and Hinges of the World' and 'Too Much and Too Little' are indeed intriguing labels to find on electrical engineering discourses, especially when the speakers are Mr. Vaughan Harries and Professor M. G. Say.

Early in the session the Education Discussion Circle have their opening meeting, when Mr. H. E. Dance and Dr. P. F. Soper are starting a discussion on 'The Architectural Features of Electrical Engineering Laboratories'. This will turn on the interior architecture and fittings of a teaching laboratory, an important and very imperfectly documented subject.

The Radio and Telecommunication Section should have an evening of popular appeal on the 28th October, when they will be informally discussing 'hi-fi' in the home. Moreover, other informal activities are this year centred on house and garden: two of the Monday Informal Meetings treat of domestic space heating and of amateur gardening (electrically). In recent years attendances at these Informal Meetings have dropped a little. This is surprising, for they are comparatively intimate, not-too-technical discussions where one may speak without the possibility of anything being taken down and used in evidence.

The second Ordinary Meeting of the session is reached on the 7th November, when Dr. Willis Jackson introduces the report on training technical college teachers, a vital subject affecting potentially a great many members. For the Report emphasizes that the country needs many more engineers from industry either transferring to full-time teaching or helping part-time with day courses.

Papers on earthing usually excite controversy, and there is likely to be a keen discussion of Mr. F. Mather's paper on the earthing of low- and medium-voltage distribution systems, which he will present to the Supply Section on the 20th November; this paper has already been selected for reading in several Local Centres, and it will be featured by a special article in the *Journal* on protective multiple earthing.

At an Ordinary Meeting in December, Dr. J. V. Dunworth, who is Head of the Reactor Division at the Atomic Energy Research Establishment, will be giving a lecture on advanced power reactors. This should have a strong appeal to members—whether themselves engaged in the nuclear power field or not—especially in the light of progress on the fast reactor at Dounreay and current interest in experiments on controlled thermo-nuclear reactions at Harwell.

An unusual combination of two Specialized Sections at a Joint Meeting occurs on the 12th December, when the Utilization and Radio Sections will discuss together a paper about stage and television lighting. A week later The Institution combines with its two sister engineering bodies to hear the Fourth Annual Graham Clark Lecture, this year to be given at The Institution of Civil Engineers by Sir Ewart Smith, a chartered mechanical engineer and a Deputy Chairman of Imperial Chemical Industries. His subject is 'The Engineer and Management', of personal importance to many engineers.

The tendency to have more talks and fewer formal papers in The Institution's programme is emphasized by two informal lectures to the Measurement and Control Section: one by Dr. J. Lamb on the 17th December on uses of ultrasonics and one by Dr. G. F. Tagg on the 21st January about the effect of modern industrial requirements on instrument design.

The first half of the session finishes at the end of January, and one of the last events of it is an important symposium which the Radio and Telecommunication Section are holding on ionospheric and tropospheric scatter propagation under the title 'Long-Distance Propagation above 30 Mc/s'. An announcement about this appeared in last month's *Journal*.

In this brief survey of the work of The Institution in the Lecture Theatre, during the first half of the session, we have mentioned only a few meetings. This is in no way to decry any of the others, nearly all of which will arouse a good response among members. There is indeed a very varied choice of subject and type of paper. Perhaps this note will suggest to some members who do not visit Savoy Place very often that two hours at an evening meeting—whether specialized or of general appeal—would not be two hours wasted. If it does no more than that it will have served its purpose.

THE SUBMARINE POWER CABLE TO VANCOUVER ISLAND

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By R. M. FAIRFIELD, B.SC.(ENG.), M.I.MECH.E., MEMBER

This article gives a short account of the submarine power cable between Vancouver Island and the Canadian Mainland, which was more fully described in a paper read at an Ordinary Meeting of The Institution on the 25th April this year. This paper was recently awarded the Institution Premium. Mr. R. M. Fairfield, of British Insulated Callender's Cables, was one of the five authors of the paper, the others being three colleagues of his and Dr. T. Ingledow of the British Columbia Electric Co.*

While the use of submarine cables for the transmission of power is not new, this is the first major installation in that the voltage used (138 kV) and the power transmitted (120 MW) both exceed the corresponding values for any similar previous installation. The Vancouver cable indeed represents a significant step in the progress of underwater power transmission, since its successful engineering development and installation have conclusively demonstrated that water is no longer a barrier to high-voltage high-power transmission of electrical energy. Important schemes involving submarine power cables will undoubtedly spring from the experience gained in the Vancouver cable, and progress will probably be further stimulated by developments in high-voltage d.c. transmission.

The manufacture and installation of the cable have been a Canadian-British venture. At the time that the British Columbia Electric Co. began studying the practicability of having a submarine power cable installed they decided that no country except Britain was capable of meeting the special engineering aspects of this project; a specially equipped factory was built in Manchester for making the cable. In the discussion on the 25th April, Sir Josiah Eccles described the project as 'a landmark', and there were tributes from Sir John Dean and others to the planning and engineering design of the cable used in it.

THE British Columbia Electric Co. serves the south-western mainland of British Columbia and the southern portion of Vancouver Island, which is separated from the mainland by the Strait of Georgia, whose total width is about thirty miles. On the mainland there are vast resources of hydro-electric power, but Vancouver Island, which includes in Victoria the Provincial capital city, has no such undeveloped resources, and by 1950 the trend of the load curve showed clearly that a substantial additional source of power would become essential during 1956 at the latest.

Studies were undertaken of the relative merits of providing the power requirements of the Vancouver Island system by means of a coal- or oil-fired generating station, an atomic station, and an interconnection with the mainland system using submarine power cables. These studies showed clearly that a submarine cable interconnection would be a very attractive proposition. Such a plan involved much difficulty, but after considering all the aspects those responsible concluded that it was feasible. They decided to proceed with a scheme which would ultimately involve a power transmission of 240 MVA over two 3-phase circuits, each circuit carrying 120 MVA and operating at 138 kV 60 c/s to link with the existing system. Seven cables would be required, three for each phase and a spare. The first stage of the scheme called for the installation of five of the cables (one circuit plus a spare and a reserve), to be laid across the Strait of Georgia and the Trincomali Channel, with overhead line transmission on the intermediate islands to provide the Vancouver Island system with 120 MVA of additional power during 1956.

The scheme was complex, and involved considerations outside the field of existing practice and experience. Submarine telegraph and telephone cable experience, although helpful, was not sufficient because of the far greater sensitivity to mechanical damage and disturbance of the highly stressed dielectric of the power cable, and its much greater weight. The design engineers gained, however, much valuable information from development work, including practical trials at sea, which had been undertaken in 1953 to prove the feasibility of a submarine power cable across the English Channel.

The area between the Fraser River delta and Vancouver Island (Fig. 1) was extensively surveyed. Existing charts were amplified by special hydrographic surveys, and accurate sea-bed contours were obtained and bottom samples collected. Currents were found to average 4 knots at the surface, and 1 knot maximum at the bottom. Fig. 1 shows the route finally adopted, the profile of which is shown in Fig. 2. The body of water separating Vancouver Island from the mainland contains a number of long and narrow islands rising steeply from the sea bed. Bottom conditions are partly sand and gravel, and partly rock, pitted with deep holes and channels having abrupt contour changes. Fortunately, a portion of this rugged sea bottom was found to be covered by silt deposited from the mouth of the Fraser River, and this part of the Strait of Georgia offered a reasonably smooth and soft bottom as far as Galiano Island, except for a ridge of

* INGLEDOW, T., FAIRFIELD, R. M., DAVEY, E. L., BRAZIER, K. S., and GIBSON, J. N.: 'British Columbia–Vancouver Island 138 kV Submarine Power Cable', *Proceedings I.E.E.*, Paper No. 2354, April 1957 (to be republished in Vol. 104.)

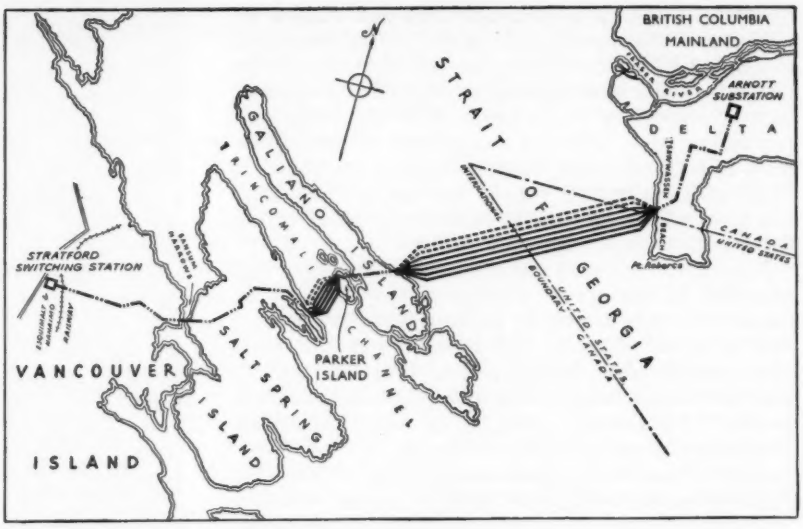
rock parallel to and about two miles from the shore. It was therefore decided to land the cables at Galiano Island.

The channels between Galiano, Parker, Saltspring and Vancouver Islands are much less attractive for cable laying. However, a detailed survey of Trincomali Channel between Parker and Saltspring Islands revealed a relatively small portion of bottom which was satisfactory, and a submarine cable—just under three miles long—was adopted for this part of the route. For the mile-wide Sansum Narrows between Saltspring and Vancouver Islands, an aerial crossing was chosen.

The experience gained from the cross-Channel development work had shown that it was most desirable to avoid joints in the cable unless absolutely necessary, e.g. for repair purposes. The ideal to be striven for was the installation of cable in continuously manufactured lengths (i.e. free from joints) throughout the submarine sections. Although this introduced major problems of its own, it had the supreme merit of eliminating many of the hazards and uncontrollable aspects which would otherwise have been present. The decision to lay the cables in continuous lengths involved the selection of a suitable cable, and its manufacture and transport in lengths of a size never before attempted. Moreover, the landing of the starting and finishing ends constituted an engineering problem on its own. The major crossing—from Tsawwassen Beach to Galiano Island—would call for five cables, each over 15 miles in length; and the total length of cable to be manufactured was 93½ miles.

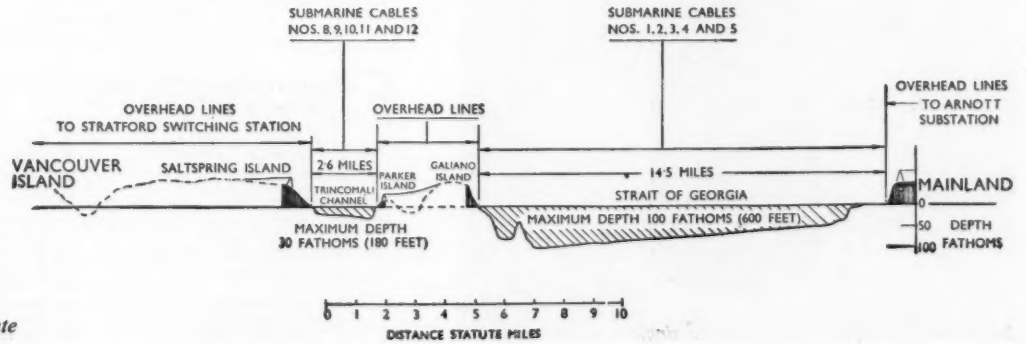
The only practical type of cable which lent itself to continuous manufacture in long lengths, and which could be developed for the duty required, was the single-core gas-filled type, using pre-impregnated paper insulation. The methods which were adopted to enable manufacture of up to nearly 16 miles of 138 kV cable in one continuous length are dealt with later. There were exceptional problems, not only on the plant side, but also in ensuring that the design standards were maintained within very close limits. Approximately 93½ miles of cable was to be manufactured. The cable had to be shipped 8 500 miles and laid, and not until installation had been completed, some 78 weeks after the beginning of manufacture, would it be possible to test the cable under alternating voltage conditions and full gas pressure. The control of materials, processes and workmanship had thus to be very good indeed.

As a precaution, the route of the cables and the landing sites were selected to avoid good anchorages, so that the cables would not be exposed to undue danger of damage from ships' anchors. The Strait of Georgia is, however, a main shipping lane for deep-sea, local and ferry traffic



1 *Mainland–Vancouver Island interconnection route*

——— Existing cable.
– – – – Projected cable.
·—·—· Overhead lines.



2 *Profile of route*

to coastal points of British Columbia and Alaska. In 1955 over 32000 vessels called at the Port of Vancouver alone. In addition there is a great deal of tug, log boom and barge traffic close inshore, as well as heavy seasonal salmon fishing by fleets up to 5000 Canadian and American vessels. With the co-operation of the Department of Fisheries, beam trawling has been prohibited in Trincomali Channel to prevent damage to the cables; but no trawling restrictions could be imposed in the Strait of Georgia.

Even after taking all possible precautions, there still remained the danger of damage to the cable during installation, or subsequently as the result of trawling or fouling by ships' anchors. A robust submarine repair joint was therefore designed, fitted with restrictors to limit the bending radius of the cable; this precaution was justified by a mishap during laying, which did in fact necessitate the use of a joint of this type.

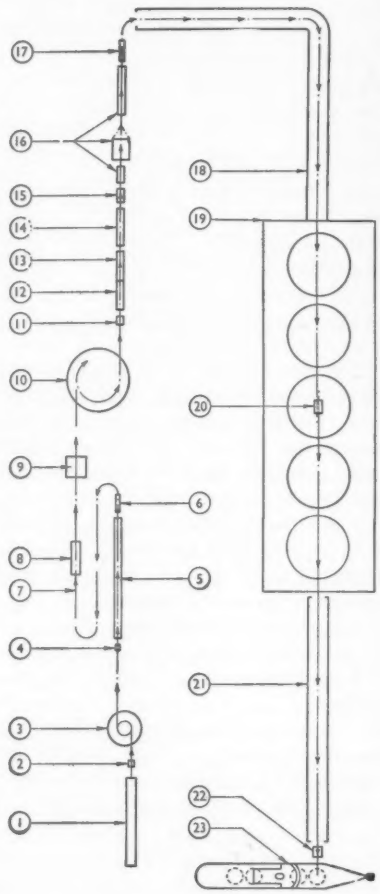
Apart from Tsawwassen Beach (Fig. 1), all the approaches were rocky with local eddies and tide-rips. Moreover, the reef off Galiano Island, rising steeply from 100 fathoms to 40 fathoms, called for special precautions during laying. After careful study of the soundings the detailed routes to be followed by the five cables were chosen; and it is a tribute to the fine seamanship of the captain and crew of the cable ship that the actual route of each cable as laid corresponds very accurately to the planned route.

Some special features affected the design of the cable.

3 *Construction of 138 kV 0·35 in.² single-core gas-filled cable*

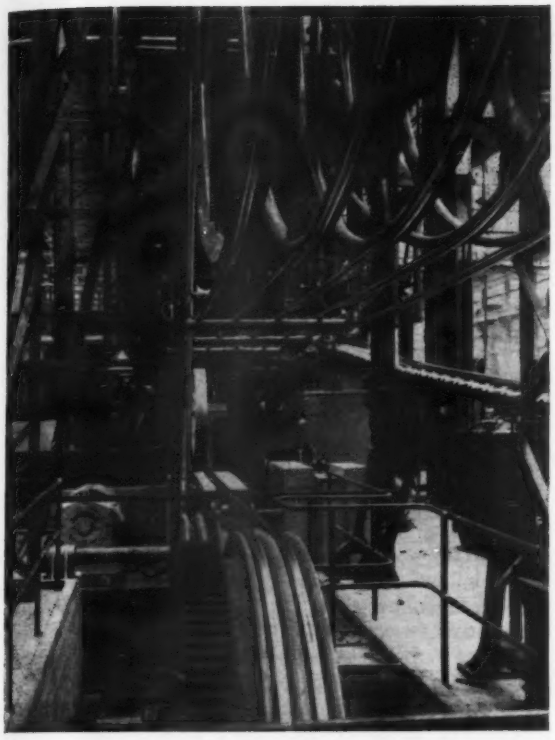
At a depth of 100 fathoms the external water pressure is 265 lb/in.², and the cable was therefore designed to operate at an internal gas pressure of 300 lb/in.² to prevent ingress of water in the event of damage. The high external pressure made it impossible to adopt the normal practice of providing a clearance under the lead sheath as a gas channel; the conductor was therefore designed with a central gas-flow duct. The outer layer of conductor wires was stranded right-hand so as to contract in diameter under coiling and avoid damage to the dielectric papers.

Alloy E was chosen for the sheathing of the cable, because of the special requirement for high fatigue



4 *Diagram of plant for continuous manufacture of submarine power cables*

1. Stranding machine.
2. Caterpillar haul-off.
3. No. 1 turntable.
4. Caterpillar brake.
5. Insulating machine in enclosure.
6. Capstan haul-off.
7. Accumulator system.
8. Accumulator output capstan.
9. Lead press.
10. No. 2 turntable.
11. Caterpillar brake.
12. Reinforcing tape heads.
13. Rubber taping heads.
14. Vulcanizer.
15. Spark testers.
16. Jute bedding, wire armouring and serving machines.
17. Capstan haul-off.
18. Transport gantry.
19. Coiling shed.
20. Coiling winch.
21. Loading gantry.
22. Loading caterpillars.
23. Cable ship.



5 *Accumulator for cable storage between insulating and lead-sheathing*

resistance. The tin-bronze reinforcing tapes were applied with a right-hand lay (i.e. opposite to that of the armour) in three layers, so that, under the tensile loads experienced during laying, their circumferential torque was opposed to and practically equal to that of the armour. This substantially reduced any tendency of the cable to throw loops on the sea bottom during laying and recovery.

Galvanized steel-wire armour was adopted in preference to aluminium armour, the abrasion resistance of which, under water, is much inferior. Between the armour and the reinforced sheath was inserted an anti-corrosion sheathing of vulcanized rubber compound (Fig. 3), capable of withstanding the transient voltages (of the order of 10 kV) which might occur.

All the design and manufacturing details were embodied in stringent specifications, and the production engineers ensured absolute compliance with these by a close and continuous system of quality control and inspection. Gas-feed equipment was provided for installation at each terminal site, embodying reducing valves and electrical contacts to provide warning of any fall in gas pressure.

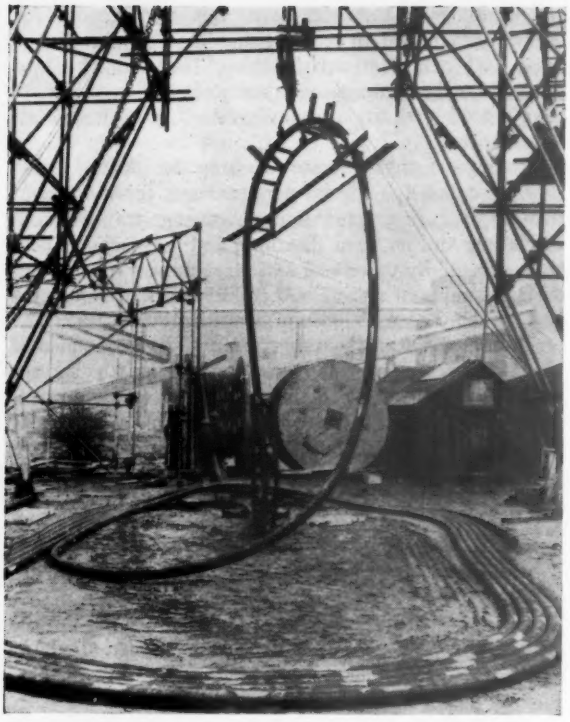
Although the intention was that the cables should be manufactured and laid without joints, the engineers appreciated that this ideal might prove to be unattainable, and joints of two types were therefore developed. The first was a 'reconstituted joint' of the same dimensions and flexibility as the cable itself; this was intended for use in the factory if an accident should occur at any stage up to and including lead sheathing. The second type of joint was a rigid submarine repair joint for use if a cable should need repairing after laying. As it transpired, both were needed.

Continuous manufacture of long lengths of cable (Fig. 4) called for special arrangements for storage at two stages during manufacture, between stranding and insulating, and between sheathing and armouring. These were effected by the use of two large power-driven turntables, capable of storing in a coil 25 miles of conductor and an equivalent length of lead-sheathed cable. The insulating and lead-sheathing processes were connected together in tandem by means of a length storage mechanism (Fig. 5) such that either process could continue running while the other was being reloaded or recharged. On completion, the 93½-mile armoured cable was housed in a coiling shed (Fig. 6), from which it could later be loaded into the cable ship via an overhead gantry 350 yards long.

Elaborate precautions were taken to ensure trouble-free continuous manufacture. Certain key items of equipment were duplicated; rigid and continuous control and inspection were instituted; and after the plant had been run in, a trial length of cable was manufactured and tested for full compliance with the specifications. Manufacture began on the 1st April 1955; and by the 2nd March 1956 the 93½ miles of cable was completed ready for shipment. The cable was shipped to site and laid by the cable ship *Ocean Layer*. This ship, of 4600 tons displacement, had recently been completely fitted out with the most modern equipment and gear and was, with her experienced captain and crew, to prove very suitable for the difficult installation operations.

The cables were to be laid without joints, from sealing-end to sealing-end. The cable ship could not be moored closer than about 1½ miles from the shore at the Tsawwassen landing, and ¼ mile off-shore at the other landing positions, and special methods were developed to lay the shore ends of cable. It was decided to adapt for the

6 *Coiling shed for storage of finished cable*



7 *Tests on land: use of 'spinner' to obviate double twist*

purpose two of the local flat-decked shallow-draught barges, known as scows. Special cable-handling gear was designed and proved both on land and in sea trials near Falmouth, particular attention being paid to the problem of paying out the coil of cable from the scow deck in such a way as to remove the twist introduced during coiling down. What was, in fact, required was some means of paying out the cable from the bottom of the coil; and this was achieved by using a 'spinner' (Fig. 7)—a rotating semi-circular frame suspended above the coil—in conjunction with a tunnel or shallow culvert beneath the turns of the coil. The device was found to work admirably, and the scows were fitted out with this and all other necessary equipment for the actual laying operation, which began on the 16th July 1956.

Laying proceeded without serious incident, except for one Trincomali Channel cable, when the ship was carried at right angles to the route by an unexpected tide-rip near Parker Island, and the cable under heavy tension rose up over the bow sheave flange and was bent to a radius of 15 inches and visibly flattened. During d.c. testing after laying, it failed at this point and a submarine repair joint was inserted. While the cable was being manufactured and transported to site, concrete chases—and at Tsawwassen Beach, a 450 ft cable subway—had been built at the terminals; up these the cables were drawn and connected to the sealing-ends, and so to the overhead line system.

The systematic programme of development and proving, the extensive survey work, the elaborate control arrangements during manufacture and the careful planning of the laying operations, all combined to bring the project to a successful conclusion; and the submarine cable link is now a satisfactory and efficient part of the British Columbia Electric Co.'s supply system, carrying substantial loads in fulfilment of the plans made four years earlier.

VARYING ATTITUDES ON TECHNICAL CHANGE IN INDUSTRY

Here Mr. Landon Goodman, Industrial Specialist of the British Electrical Development Association, writes about an important book published this year which deals with the application of new scientific developments to British industrial firms. Much—perhaps too much—has been written and said on this subject since the Second World War; but the facts revealed by the authors, and their conclusions, should not be overlooked by anyone concerned with some individual aspect of the present struggle to keep Britain's industry competitive in the markets of the world.*

L. LANDON GOODMAN, B.SC.(ENG.), ASSOCIATE MEMBER

THE origin of this book is to be found in a decision of the Council of the British Association in 1952 to appoint a committee 'to study the problems of speeding up in industry the applications of the results of scientific research'. The Royal Society of Arts and the Nuffield Foundation agreed to join the British Association in sponsoring the investigation, and a 'Science and Industry Committee' was appointed with a full-time staff who were organized in two research units, one at Keele under Professor B. R. Williams, and the other at Belfast under Professor C. F. Carter. The book is thus a report on various matters which affect the speed of application of science in industry. In this volume the problems are stated; a further report will suggest ways of increasing the speed.

Among the factors considered are basic research—its initiation, extent, and application; management and research; industrial organizations; capital; taxation; and trained men in industry. The report contains much valuable information and can be recommended. Many of the conclusions reached are important and interesting; some are manifest to industrial observers. Yet again, others could be taken much further.

* CARTER, C. F., and WILLIAMS, B. R. (on behalf of the Science and Industry Committee): 'Industry and Technical Progress: Factors governing the speed of application of science' (Oxford University Press, 1957. 25s. 252 pages).

The authors show that progressiveness in science and technology is not an optional extra which a firm can add to its existing qualities, but an expression of its general attitude and the efficiency of management—'Efficient management is receptive management; inefficient management is unreceptive management'. They stress the need for the training of individual managers with an interest in, and an appreciation of, science and technology. The investigators often found that firms highly resistant to new ideas are in a traditional industry and are ones which recruit potential managers at an early age, train them solely in the technical knowledge of the particular firm and industry, and pride themselves on 'practical' management, independence, and self-sufficiency. Indeed, the most common cause of technical change appeared to be a change of senior management, and the main barrier to rapid change the traditional methods and attitudes of existing managers. Thus the quality of management is a prime criterion of technical progress. The authors believe that there is no particular type of organization which gives the most promise of success, but consciousness of the need for technological progress on the part of the board and of the chief executives is a matter of the greatest importance. They conclude that there is no systematic and general connection between the size of firms, the type of industrial organization and the possibility of technical progressiveness. But is this the whole story? Examples could be quoted of 'parochial' (unprogressive) firms in which the organization itself has the wrong structure because of the wrong management attitude. (See, for example, a paper by T. Burns* to the British Institute of Management 1957 Midlands Conference on 'Management and Innovation'.) Structure is often an excellent guide to *real* management attitudes.

The report has some interesting points to make on the importance of selling research and of the need for personal contacts. For example, when a certain research association introduced a new instrument it advised its members; only five per cent replied to a request to express interest on a business reply postcard, and yet eighty-five per cent of the members ordered the device after liaison officers had visited the firms and demonstrated it. There can be no doubt that the 'scientific middleman' (or the 'liaison engineer' as he is now called in the United States) has a very important part to play in speeding up technical progress.

Developments in relatively new branches of technology are frequently impeded by the absence of scientists and engineers with training or competence in more than one field of study. The authors note also that too few scientists and engineers are engaged in production and in sales relative to the number engaged in research; and this fact is underlined by the observation that those companies which are most progressive in technological matters are equally progressive in all their other activities. An important finding is that the best use of scientists and technologists has not received the attention that it requires. The investigators found too that the efficiencies of drawing offices and design offices had not usually been studied. Research brought to light only two out of 150 firms which had put their best efforts into the task of increasing productivity in these departments.

Firms were divided for the investigation into three categories. The firm which is self-satisfied in its isolation and is confined within self-imposed and narrow limits falls into the first category and is called parochial. Those which are receptive to new ideas but which rely on some other firm or agency to provide them come in the second category. The third category comprises firms which are neither parochial nor parasitic on the development work of others and are often truly creative. Interesting figures based on the survey show how far the parochial firm is behind the leaders in technical progressiveness and in the percentage of adequately trained staff employed. It is extremely difficult to persuade parochial firms to change their standards of performance and, *inter alia*, this may have important consequences, for whenever a chain of firms is involved in development, progress can be no faster than the weakest link of the chain allows. Thus some firms which are indifferent to the needs of technical progress may retard others.

It is interesting to note that, outside two groups of industries (the chemical trades and the food, drink and tobacco trades) there is little evidence of a general relationship between capital expenditure per employee and size of establishment. More significant perhaps is that an analysis of the financial results of 500 companies showed a clear relation between the growth of profits and assets on the one hand and scientific and technological progress on the other. It was found that fifty firms with the worst profit records had directors with known qualifications below the average for the 500 firms investigated; fifty firms with the best profit records had more than the average number of directors with professional qualifications. It seems unfortunate in more ways than one that most of the firms visited were unable to give a precise figure for their spending on research. The report, incidentally, gives a list of twenty-four characteristics of progressiveness present in a sample of some fifty firms, and these make interesting reading.

The authors aptly conclude that 'people may laugh at the supposed American worship of novelty, but we would suggest that the creation of a public opinion which is proud of technical change is no small part of the conditions for achieving that change'.

The report should be widely read. It is unfortunate that it is not presented in a more readable form, with more headings and with frequent summaries.

* The full paper has not yet been published, but a résumé of it appeared in *The Manager*, 1957, 25, No. 5, p. 382.

CORRESPONDENCE

INDUSTRIAL MANAGEMENT FOR PROFESSIONAL ENGINEERS

From Pilot Officer J. G. DICKSON, B.SC., STUDENT*

I read with very considerable interest the series of articles in the *Journal* on 'Industrial Management for Professional Engineers'.

These articles were most informative, especially—for me—the one on 'The Manager and His Men', in which the writer outlined the methods of selection and training of potential managers. I consider that one of the most important factors determining the quality of a manager is his ability to assess the character of other men with whom he comes into contact. My own experience in charge of a section of forty men has proved the immense value of being able to select one leader from a group of say a dozen men. In this respect my National Service has proved a useful training ground.

Thank you for some very profitable reading.

* Pilot Officer J. G. Dickson is with the Royal Air Force.

NEW E.R.A. CENTRE AT LEATHERHEAD

Opening of the Cleeve Road Laboratory by Lord Mills

THE expansion of the Electrical Research Association from its modest beginnings as an extra-mural research association in 1920 has exerted continual pressure on the available space, and during the Second World War it was realized that the main establishment at Perivale would no longer be adequate. Accordingly, a 48-acre site was acquired at Leatherhead, and the construction of new laboratories began in 1954. During the past year three-quarters of the work formerly carried out at Perivale has been transferred to Leatherhead, and the new laboratories there were opened by Lord Mills, Minister of Power, on the 26th June 1957.

In warm afternoon sunshine the guests assembled on the lawn in front of the building for the opening ceremony. The large marquees behind them gave the scene the friendly atmosphere of a summer fête. At 3.30 p.m., Sir Gordon Radley, President of both The Institution and the E.R.A., introduced Lord Mills, who said that he was impressed by the past achievements of the E.R.A., and that he was convinced of the importance of electrical research. During his lifetime Britain had fallen from the leading position which she had attained in the first industrial revolution, and it was necessary to hold our place in the second industrial revolution, which will be based on electricity generated by nuclear power.

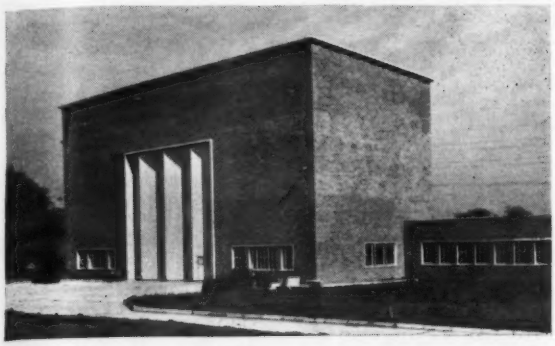
Lord Mills then formally opened the main building with a commemorative key, and for the rest of the afternoon the laboratories were inspected by the guests, who included many leading personalities in the electrical industry.

The external appearance of the main building is clean and functional, as may be seen from Fig. 1. A somewhat unusual feature is the combination of long, low windows on the ground floor with tall windows on the first, mezzanine and second floors. In this way the architect, Mr. Herbert J. Rowse, has achieved an effect of dignity reminiscent of the classical tradition of English architecture—an effect which is often absent in modern buildings, where the call is for windows which completely span the room. It is a pity, however, that the rare good taste and proportions of the building are somewhat marred by the rather undistinguished front entrance.

The other buildings on the site are the high-voltage building (Fig. 2) and the workshop. The site has been laid out to allow an orderly future expansion.

The main building has three floors and a mezzanine floor, which contain standard functionally interchangeable laboratory units, together with a library, a photographic department and office accommodation. A large part of the first floor has a height of 18 ft, the remainder

1 *Cleeve Road Laboratory, main building*
The high-voltage building is on the extreme right.

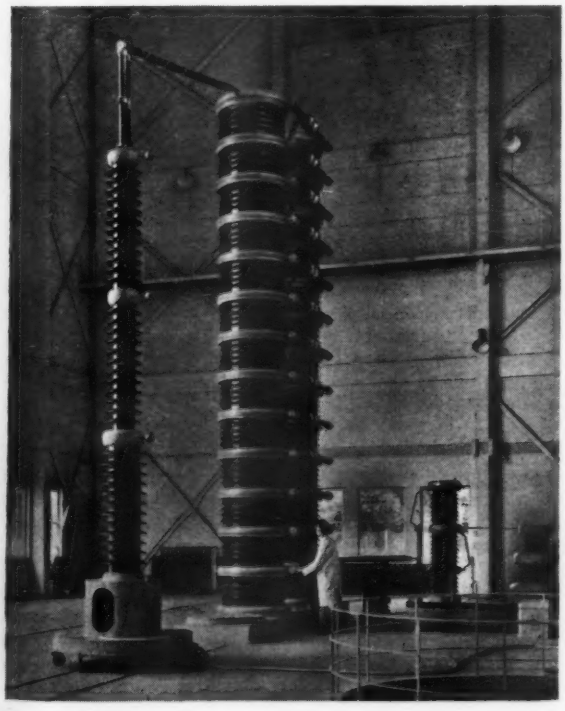


2 *The high-voltage building*
The doors are power operated.

being covered by the mezzanine floor. This arrangement allows space for work requiring headroom, while the mezzanine floor provides additional working space and an observation platform.

The impressive high-voltage building comprises a central hall 50 ft high flanked by wings of normal height containing a transformer laboratory, generator room, instrument room, dark-room and offices. The building is designed to accommodate a 2·8 MV surge generator (Fig. 3), a 1 MV 50 c/s test transformer set, a high-current surge generator and high-voltage d.c. apparatus. This equipment provides for tests corresponding to the highest supply voltages at present contemplated.

3 *The 2·8 MV surge generator*



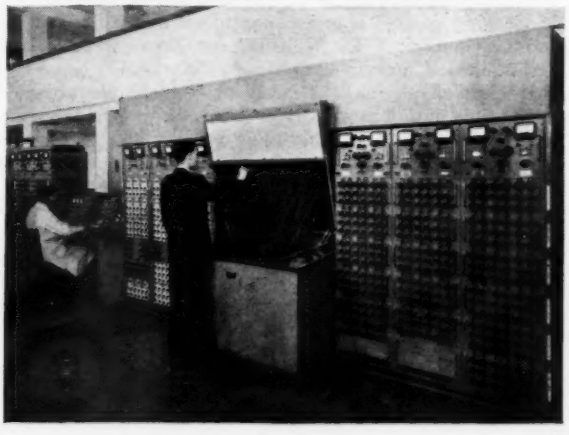
The Association has availed itself of the opportunity of studying electrical storage heating at close quarters by installing in the various buildings all three systems—hot-water storage, floor heating and local block storage.

In planning the main building it was decided to provide only for those researches which were essentially interdependent, and among the subjects studied at Leatherhead are: cables, transformers, lightning-fault statistics, heating (including heat pumps), the electrical strength of dielectrics, transmission problems, electric arcs, radio interference, explosive atmospheres, automotive systems, the physics and chemistry of materials, crystal physics, rural electrification and surge generators. A network analyser (Fig. 4) is under construction, and a quarter of the complete equipment is already operational. When complete, the analyser will be as large as, and more accurate by an order of magnitude than, any other known to exist, and it is unique in its frequency range of 100 : 1 about a base frequency of 1 592 c/s. The main building also contains a mathematics section and an apprentices' education and training laboratory.

The Institution is proud to have played a leading part in the negotiations that led to the formation of the E.R.A. in 1920. Two members of the Council of the E.R.A. are nominated by The Institution, which also contributes annually to the Association's funds. Since its formation the E.R.A. has rendered invaluable service to the electrical industry and to the country in general. A recent estimate of the cash value of the results of its researches is not less than £1 000000 per annum. It has been said by the Earl of Mount Edgcumbe that the E.R.A. is 'raising the prestige of this country in the eyes of the engineering and scientific world. . . . All this has a very definite bearing on the country's exports.'

The fine laboratories at Leatherhead are a recognition of past achievements and a hopeful investment for knowledge yet to be won.

4 *The network analyser*
Above the analyser can be seen the mezzanine floor.



Engineering Womanpower

At a conference on 'Careers for Girls in Engineering', held at the City of Coventry Training College on the 13th and 14th July, Dr. Willis Jackson stressed the dependence of the electrical engineering industry on progress in other sciences, and urged that girls should be encouraged to study physics, mathematics and chemistry to G.C.E. advanced level before engineering. He considered that an important step in fully exploring the career possibilities was the setting up of the Manchester Committee under the chairmanship of Miss Anne Shaw.

The conference, organized by the Women's Engineering Society, was attended by nearly 200 representatives of education and industry, including an impressive number of women engineers. In view of the recent Government White Paper,* the Society hoped to clarify the present prospects for girls in engineering.

Opening a session on technical education, Professor D. C. Johnson, of Leeds University, spoke of the possibilities for women graduates. He had found that, although the large electrical, chemical and aeronautical engineering firms would accept women, from the rest there was 'guardedness and some open hostility'. He advised women graduates to enter a two-year post-graduate apprenticeship where possible, since they would then be better equipped to overcome prejudice by having had the basic industrial training.

Professor Johnson estimated, however, that in his own department, Mechanical Engineering, he could at present accept only about one in every five applicants, whether men or women. Men with high qualifications had to be turned away, so that a prospective woman student would need a very high standard of education and ability to survive the competition. He emphasized that technology should not be considered as a second choice to pure science.

Dr. P. F. R. Venables, Principal of the Royal Technical College, Salford, said that, of 70000 full-time students at technical colleges and institutes, 48% were women. Despite this encouraging proportion it appeared that, in part-time schemes at least, women were less likely to stay the course. Dr. Venables quoted figures for day-release students, of whom 16% were women, showing that from the 15–17 age group, where the ratio of women to men in training was 1 to 5, to the 18–20 group, where the ratio was 1 to 14, the number of men attending declined by 50% and of women by 85%.

Speaking of the 'marriage hazard'—the disadvantage of training young girls—Dr. Willis Jackson, Director of Research and Education, Metropolitan-Vickers Electrical Co., suggested that until a substantial number of women had occupied responsible positions for some time there would remain doubt as to the justification of this expense. But, if a woman engineer could be employed for 4–5 years after training, it should be economic for the firm to train her.

Sir Ronald Nesbitt-Hawes, Chief of Education Administration, English Electric Co., estimated that it would cost a firm about £2000 over 5 years to train the 18-year-old girl. He considered that a woman would be better able to resume her employment after a break if the present 5-year sandwich course were replaced by a 2-year training in basic techniques, followed by a 3-year specialization as a member of a team.

Openings for women graduates in many departments of the aircraft industry, at salaries ranging from 80% to 100% of 'the rate for the job', were mentioned by Cmdr. Charles Godwin, Technical Personnel Manager, Armstrong-Siddeley Motors. Two factors against the acceptance for training of 16-year-old girls were the attitude of the Trade Unions and the manual work involved in the shops. Few automobile engineering firms encouraged women engineers.

Dr. Winifred Hackett, Associate Member, addressing the conference. Mrs. I. H. Hardwich, Associate Member, is in the Chair

The final speakers at the conference were professional women engineers, including Miss M. I. Fergusson, the first woman to become, last year, a full Member of The Institution of Civil Engineers, and Dr. Winifred Hackett, an Associate Member of our Institution who is Head of Mathematical Physics, English Electric Guided Weapon Division. Dr. Hackett urged education representatives to give early training in the presentation of technical information.

During an Open Forum, Mr. J. E. C. McCandlish, of the Scottish Electrical Training Scheme, mentioned that five Scottish firms had set up engineering apprenticeship schemes in January, and that although his Board felt they should first recruit men, they were all anxious to include women engineers on their staff. For younger girls an *ad hoc* training (including day release) was provided, different in content from that provided for men, where the objective was the Ordinary or Higher National Certificate.

The conference was essentially an exploratory one and no formal resolutions were passed. There was evidence that in the past, and probably now, a woman science or engineering graduate who undertook a two-year post-graduate apprenticeship with a firm stood the best chance of reaching a responsible position. There was now, however, a lack of accommodation in most engineering faculties, and an alternative route was by way of full-time or part-time technical college courses. Many firms, especially aircraft, electrical and chemical, encouraged part-time technical training, more especially for girls over 18; the 16-year-old was advised to stay at school, studying physics, mathematics and chemistry, until she was 18.

Mr. Iain Macleod, Minister of Labour, closed the proceedings by urging 'a thorough appraisal' of those jobs suitable for girls at all levels in engineering. The situation was a challenge both to industry and to education, and he concluded by reminding teachers that in this present age engineering was the most exciting career of all—for both boys and girls.

* 'Scientific and Engineering Manpower in Great Britain' (H.M.S.O., 1956).

SHORT REVIEWS OF PAPERS

On the following pages are some brief review articles based on, and written by the authors of, current Institution papers. The authors have been asked to make these articles, so far as possible, interesting and of appeal to electrical engineers who have no specialized knowledge of the subjects, and the content of the articles is not necessarily confined to the subject-matter of the original papers.

Earthing of Power Stations

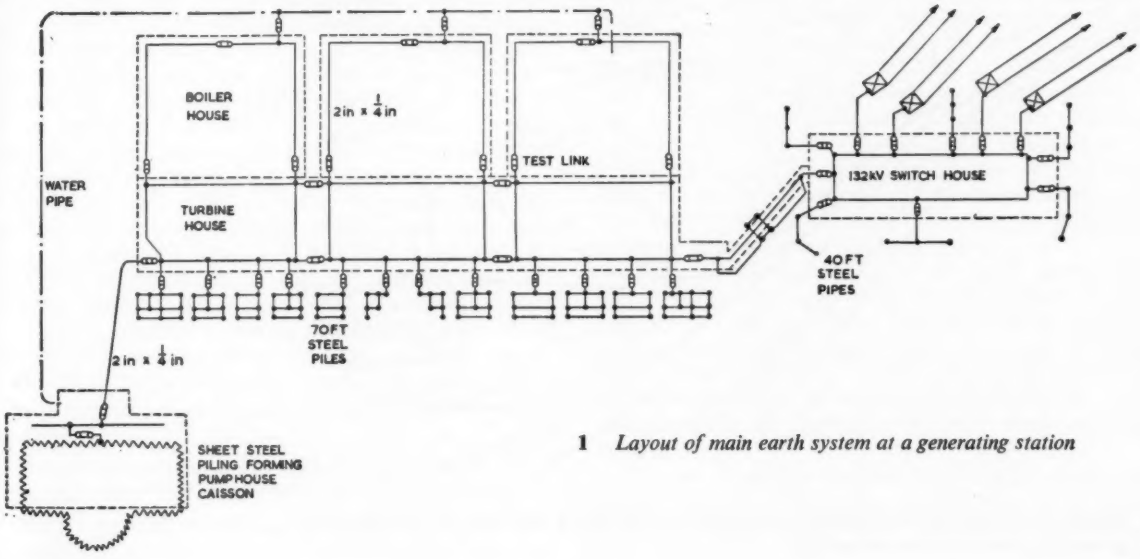
A short review of a Supply Section paper (No. 2341) entitled 'Earth-Electrode Systems for Large Electric Stations', by J. D. Humphries, B.Sc.(Eng.), Associate Member. The paper was published individually in March 1957, and it is published this month in Part A of the Proceedings. The author is with the United Steel Companies, Ltd., Sheffield, and was formerly with the Central Electricity Authority (South Wales Division).

THE INCREASING CONCENTRATION OF GENERATING PLANT and the more common use of direct earthing for transformer neutrals have resulted in a great increase in the magnitude of earth-fault currents that can occur in a power system. There has been little information published on the design of earth electrodes suitable for handling these increased fault currents, and the paper calls attention to the special problems involved.

Earth-fault currents as high as 15000 amp can occur, and the limitations imposed on permissible voltage rise and voltage gradients in the vicinity of the earth electrodes require that the effective resistances of earthing systems must often be less than 0·03 ohm. It is these low values of resistance which are the main source of difficulty in designing suitable earth electrodes, especially in neighbourhoods of high soil resistivity. Even when a satisfactory design is achieved, specialized measuring techniques are required to permit the accurate assessment of the efficiency of the electrode system.

Owing to the high current densities encountered, it is virtually impossible to design satisfactory isolated earth electrodes to satisfy modern requirements, and it becomes necessary to consider the earthing of every station as an integrated unit, where advantage is taken of the dissipation conductance provided by every piece of metal in contact with the ground. In the design of earth-electrode systems an attempt is made to approximate to a continuous mat of metal covering the whole site, and in small substations with very high fault currents this equipotential area becomes essential to avoid steep voltage gradients within the station boundary, and also to provide an adequate dissipating surface for the fault currents.

In outdoor switching sites a considerable network of earth busbars is required to interconnect all the items of plant, structures, etc., and if consideration is given to the problem at an early stage it is possible to design these interconnections to form a satisfactory mesh-type



1 *Layout of main earth system at a generating station*

electrode in themselves, thereby avoiding the expense of separate electrodes.

Where such interconnections are not available, recourse must be had to one or other of the more conventional types of electrode, such as plates, rods, strip, pipes, etc. It should not be forgotten that many types of civil-engineering structures can form ideal electrodes. Examples of these are steel piles, cooling-water pipes, steel building frames, and caissons, and (where the soil resistivity is as high or higher than that of concrete) the use of reinforced concrete structures and piles is attractive.

Fig. 1 shows the earthing system of a large modern power station, which illustrates the extensive nature of the works required. This station is of 345 MW capacity and has a prospective maximum earth-fault current of 10 000 amp. The site is approximately 600 yd long.

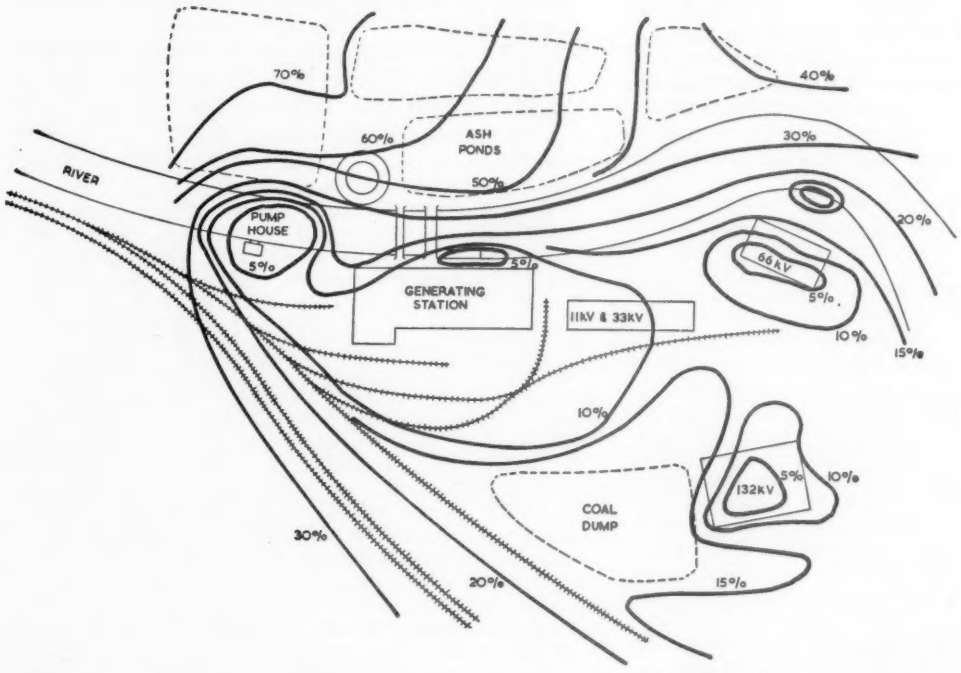
The criterion of efficiency of an earth-electrode system is generally taken to be the *dissipation resistance*. This is the resistance of the electrode system and the surrounding ground, measured with respect to the general mass of the earth. The method of measurement invariably requires the passing of a current from some form of generator, through the electrode under test and the surrounding ground, to an auxiliary electrode placed at a remote point, and then via a temporary return lead. Potential differences are measured between the electrode under test and a probe inserted in the ground at a sufficient distance, and from the measurements of current and voltage the dissipation resistance is determined.

The straightforward measurements mentioned above are liable to error due to a number of factors, such as electrolytic potentials, stray alternating currents, induction in the test leads, etc., as well as the normal instrument errors arising in the measurement of very low resistances. It is in the methods of combating these errors that the various measuring techniques differ, and the author discusses two new methods which depend on the measurement of phase angle of the potentials picked up. In the later method a form of a.c. potentiometer is used to determine the magnitude and phase angle of all potentials, thereby permitting allowances to be made for the various disturbing influences.

When measurements of dissipation resistance are being made at a station, it is of great benefit to conduct a survey of potential distribution in the vicinity of the station under earth-fault conditions. Such a survey can be of considerable assistance in assessing the efficacy of the earthing system and can also give guidance in future design problems. Fig. 2 shows the potential distribution obtained at a large generating station.

The author concludes by emphasizing the necessity for further investigation into the design of large earthing systems, so that more efficient and economical systems may be obtained. Casual electrodes are no longer satisfactory. Before any such work can take place, however, it is essential that satisfactory measuring techniques are developed, suitable for the extensive stations now being constructed.

621.316.995



2 *Equipotential lines in the neighbourhood of a generating station during earth-fault conditions*
Percentages given are of total voltage drop.

Basic Analogue Computing

A short review of a Graduate and Student Section paper entitled 'Basic Analogue Computing applied to Control-System Synthesis and Analysis', by R. D. Langman, B.Sc.(Eng.), Graduate. The paper was read before the North Staffordshire Graduate and Student Section on the 14th November 1956, and it was awarded a Graduate and Student Premium by the Council. The author was formerly with the Research Department of the English Electric Co., and is now with the Research and Development Laboratories of the United Steel Co.

DURING THE LAST DECADE LINEAR ANALYSIS OF FEEDBACK control systems has been firmly established. With the growing complexity of control systems comes the need for providing rapid and reliable analysis. The basis of most physical and control analysis is founded on the derivation and solution of algebraic differential equations. The analytical manipulation of these equations is usually tedious, and for the investigation of parametric changes analytical methods are unwieldy.

The introduction of computers to the solution of such equations may be approached by two methods—digital analysis and analogue analysis. Digital analysis provides a means of establishing the numerical analysis of equations. Analogue analysis is made possible by the introduction of devices which allow physical quantities to obey mathematical relationships comparable with those of the original problem.

The choice of the type of analysis to be employed on a given problem is an important step. Where a problem requires accuracy in solution, and where the requirements are definitely stated, the digital machine is preferable, the final result depending on the interpretation of a series of arithmetical processes. An analogue computer would be preferable where no ambiguity is likely to occur owing to a misinterpretation (on the part of the operator) of the mathematical equations describing the problem, and where absolute accuracy is not important. In practice, it is true to say that the ideal method of approach to a control problem would be to solve it on an analogue computer in order to obtain a near-optimum system and to use the digital machine for a confirmatory accurate analysis.

In the author's view, the most convenient type of analogue computer for studying control-system problems is that comprising a number of high-gain d.c. electronic amplifiers (supplied by a suitably stabilized power supply), resistance-capacitance networks for transfer-function simulation, a forcing-function generator (the unit which is responsible for providing an input signal to the analogue), and suitable monitoring equipment.

Two methods of analysis are made possible by such a computer:

(1) physical representation of a given problem; and
(2) representation of the equations defining a given problem.

In the first method, which is more readily understood by engineers, a physical system is broken down into its component transfer functions using the well-known Laplace transformation calculus. From these transfer functions a block diagram is formulated, and it is at this stage that the analogue computer is used. Each transfer function, or convenient group of transfer functions, is represented by a computer unit, and a mathematical model of the system is constructed.

Most control systems possess non-linearities of one sort or another, and it is in the study of such non-linear systems that the use of an analogue computer is most apparent. The three most common types of non-linearity existing in practice are:

(1) sudden gain changes, such as occur with saturation effects, current limiting and backlash;
(2) continuous gain changes, as, for example, in empirical relationships; and
(3) multiplication or division.

A simple diode network may be used to represent a saturation effect, and this network may be developed for use as a current-limit analogue, and, when incorporated in a closed loop, as an analogue of backlash effects. As a practical example, two such networks incorporated with a commercial type of d.c. amplifier may be used to simulate a square-law relationship, and this unit may be used in turn to provide the means of simulating the processes of multiplication and division.

It is useful at this stage to consider a typical application of the computer, namely the simulation of a Ward–Leonard control system driving a rotary water pump, the load law being such that the torque demanded is proportional to the square of the speed of rotation. Closed-loop control of the system is provided.

A reference voltage proportional to the required speed setting is applied to an *LC* network. The network measures the difference between the input setting and the output speed measured by a tachogenerator. The error signal is fed to a two-stage electronic amplifier, the first stage of which saturates at 150 volts, and the second well in excess of 600 volts. The push-pull output of this amplifier is mixed magnetically in two fields of an exciter. In turn, this exciter feeds the field of a 400 volt d.c. generator. The generator feeds an 850 h.p. motor to operate at a supply voltage of 380 volts with a full load current of 1 750 amp. Current limit, commencing at 1 900 amp, is supplied to prevent serious overload under fault and accelerating conditions. The motor field is connected to a constant-voltage source, and the armature is mechanically connected to the pump.

From the block diagram of this quite complicated system the analogue-circuit diagram is derived. In practice, two variable-gain loops simulating *CR* stabilization of the error amplifier are provided, by means of which the computer operator is quickly able to optimize such a system and derive the transient performance of motor speed and armature current to an input step of reference voltage.

The use of such computational methods should lead to a sharp reduction in the analysis time of problems involving transients and complex differential equations.

621.317.79 : 681.142

SYNOPSES OF PAPERS

The following are synopses of papers published in the *Proceedings* which have not been read at an Institution meeting and which have not been described under 'Short Reviews of Papers'. They are included here primarily for reference. The papers have not been published individually, as have those for reading at meetings, but reprints of them will be available shortly.

Ni–Cr–Al–Cu Resistance Wire

A synopsis of a Measurement and Control Section paper (No. 2398) entitled 'The Electrical Characteristics of a Nickel-Chromium-Aluminium-Copper Resistance Wire', by C. Dean Starr, Ph.D., and T. P. Wang, Ph.D. The paper was published in September 1957 in Part B of the Proceedings. The authors are with the Wilbur B. Driver Co., New Jersey, U.S.A.

THE CHANGES IN ELECTRICAL RESISTANCE AND TEMPERATURE coefficient of resistance during the heat treatment of a nickel-chromium-aluminium-copper alloy, known commercially as Evanohm, are presented. From the nature of the resistance/temperature curve and X-ray diffraction data, it is proposed that the electrical changes be attributed to short-range order.

Data are presented to show that both the mean temperature coefficient of resistance and the minor deviations in linearity in the resistance/temperature curve vary in a systematic manner during heat treatment and that the changes are independent of prior thermal history.

Resistance changes after heat treatment, caused by surface tarnishing, oxidation, or the application of strain during fabrication, are discussed. 621.316.842 : 621.315.55

Electrical Process Heating

A synopsis of a review of progress (paper No. 2409) with the above title, by O. W. Humphreys, C.B.E., B.Sc., F.Inst.P., Member, and R. Smith, B.Sc., A.Inst.P. The review is published this month in Part A of the Proceedings. The authors are with The General Electric Co.

THIS PROGRESS REVIEW COVERS THE LOW- AND HIGH-temperature treatment of metals and of non-metals such as glass, ceramics, plastics, rubber and wood.

Of the new types of heating element developed in recent years, molten glass is being used in reheating furnaces. For higher temperatures, graphite and molybdenum elements are used in resistance furnaces for the treatment of special materials and for brazing. Increasing use is being made of resistance furnaces for the treatment of metals in controlled atmospheres. Processes carried out in atmosphere furnaces are bright annealing, decarburizing, malleableizing, carburizing and carbo-nitriding.

The proposal to use electricity in the melting of glass is not new, but it has only recently been used in this country on a commercial scale. Furnaces are in use for melting heat-resisting glass, and high efficiency and low initial and maintenance costs are claimed. In the field of ceramics the use of electricity for pottery-firing processes has increased considerably in the last few years. This has been brought about by the growth in the number of intermittent kilns installed.

Notable amongst the wide range of induction heating applications is the heating of steel prior to forging. The use of mains-frequency induction heating is also growing. Light-alloy billets are successfully heated by this method. The process is also being applied to the stress relieving of welded structures and to the heating of platens, rolls and parts of plastic-moulding machines.

Dielectric heating is being used for the welding, or seaming of thermoplastic sheets in the manufacture of garments, fancy goods and packages. The curing of synthetic resin glues in furniture assemblies is accelerated by dielectric heating.

The principal use of radiant heating ovens is for stoving-paint finishes on metal products, but recent developments have enabled the processes to be applied to wood. A wide range of plastic materials is also being treated in radiant heating ovens. 621.36

Frequency-Lock A.F.C. Circuit

A synopsis of a Radio and Telecommunication Section paper (No. 2411) entitled 'The Frequency-Lock A.F.C. Circuit as a Means of Tracking Signals of Changing Frequency in Conditions of Low Signal/Noise Ratio', by R. Leek, B.Sc.(Eng.), Graduate. The paper will be published in Part B of the Proceedings. The author is with the English Electric Co.

A FREQUENCY-LOCK A.F.C. LOOP WAS USED TO LOCK AND track a weak c.w. signal of changing frequency in the presence of high levels of noise.

The author discusses qualitatively from first principles the noise-free operation of the loop as a tracking system, and gives a theoretical analysis. He considers the tracking performance of the loop for the case where the signal is in the presence of noise, and introduces the concepts of the 'maximum rate of follow' and the 'mean time-to-unlock'. An examination of the errors resulting from the noise and from changes in the signal frequency leads to a theory of the loop operation for signals in noise.

A range of practical results is presented which provides agreement with this theory within the expected experimental error. 621.316.726.029.6 : 621.373.42

Ferrous and Non-Ferrous Waveguides

A synopsis of a Radio and Telecommunication Section paper (No. 2416) entitled 'Characteristics of Some Ferrous and Non-Ferrous Waveguides at 27 Gc/s', by J. Allison, B.Sc.(Eng.), Ph.D., Graduate, F. A. Benson, M.Eng., Ph.D., Associate Member, and M. S. Seaman, B.Eng., Graduate. The paper will be published in Part B of the Proceedings. Dr. Allison and Dr. Benson are at Sheffield University; Mr. Seaman was formerly at Sheffield University and is now with Pye Ltd.

MEASUREMENTS OF THE ATTENUATIONS PRODUCED BY air-filled, rectangular waveguides of brass, copper, aluminium, nickel silver, nickel, mild-steel, Radiometal, Rhometal and Mumetal have been made at a frequency of 27 Gc/s, and the effective permeabilities of the ferrous materials at this frequency have been estimated from the results. 621.372.822

Rods for Yagis

A synopsis of a Radio and Telecommunication Section paper (No. 2430) entitled 'An Investigation of Periodic Rod Structures for Yagi Aerials', by J. O. Spector, Ph.D., Associate Member. The paper will be published in Part B of the Proceedings. The author was formerly at Imperial College, London University, and is now with the Ministry of Defence, Israel.

THE PERIODIC STRUCTURE OF CONDUCTING RODS, NORMALLY used for Yagi-type aerials, is investigated from the point of view of a guide for surface waves. In a series of resonator experiments it is found that a non-radiating plane surface wave of the HE_{11}-mode may be guided along the structure, and that radiation occurs only from a discontinuity. The guiding effect is found to exist only where the rod lengths are less than $\lambda/2$. The structure is thus analogous to a capacitively loaded transmission line. The propagation coefficients are experimentally determined for structures of different rod length and spacing. These propagation coefficients are used to predict the radiation patterns of Yagi aerials in conjunction with the theory outlined in a previous paper. 621.396.677

2:1 Pole-Changing Motor

A synopsis of a Utilization Section paper (No. 2399) entitled 'A 2 : 1 Pole-Changing Induction Motor of Improved Performance', by Professor G. H. Rawcliffe, M.A., D.Sc., Member, and R. F. Burbidge, B.Sc., Graduate. The paper will be published in Part A of the Proceedings. Professor Rawcliffe is at the University of Bristol, and Mr. Burbidge, who was formerly at the University of Bristol, is now with the English Electric Co.

THE PAPER EXPLAINS A VERY SIMPLE METHOD OF MUCH improving the performance of 2 : 1 pole-changing induction motors. In spite of the extensive use of such machines for a very long time past, windings of standard type, as described in most advanced textbooks, seem always to have been used. The new winding discussed in the paper has given excellent results on test. 621.313.333

I.E.C. MEETINGS IN MOSCOW

SOME technical committees of the International Electrotechnical Commission met this year from the 2nd to 12th July in Moscow—at the Lumonosov University, on the outskirts of the city. About 300 delegates participated in meetings of 15 committees; the largest delegation was, as might be expected, the Russian (over 100 members), while the largest foreign delegations were those from the United Kingdom (52), France (34), Germany (31) and the United States (23). Twenty-three countries were represented and, in addition, observers were present from the Chinese Republic.

At the opening meeting the delegates were welcomed in general assembly by Mr. A. S. Pavlenko, at that time Deputy Minister in charge of Power Stations; two days later he was promoted to Minister in place of Mr. Malenkov.

The work of the technical committees ranged over a wide field from lampholders to high-voltage circuit-breakers. It resulted, at the end of the meeting, in the Committee of Action being able to authorize the publication of several documents as I.E.C. recommendations and the circulation of a number of drafts for comment or final approval. New committees are to be set up to deal with the following four subjects: non-industrial fans; electronic measuring instruments; electrical equipment of machine tools; safety of electric welding equipment. The United Kingdom is providing the secretariat for the last committee.

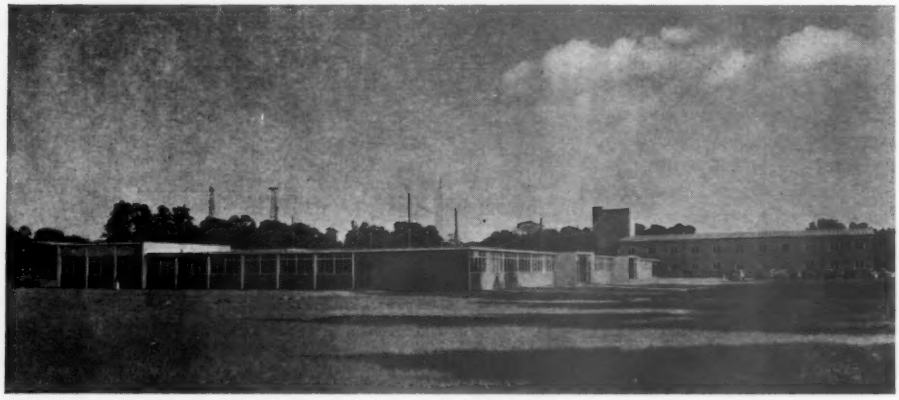
An interesting decision of the Committee of Action was that in future each I.E.C. publication will be issued in two volumes, one containing, as at present, the English and French texts and the other containing English and Russian texts.

The Le Maistre Memorial Lecture, which was instituted in 1953 to perpetuate the memory of the late Charles le Maistre, General Secretary of the I.E.C. and a former Director of the British Standards Institution, was delivered this year by Professor R. O. Kapp. He spoke in the Great Hall of Moscow University on 'The National Acceptance of International Standards'. Copies of this Lecture, which is very readable, may be obtained from The Central Office of the I.E.C., 1 Rue de Varembé, Geneva, Switzerland.

Visits to many places of technical interest in and around Moscow were arranged. These included power stations, an electrified railway, a 400kV substation and the television centre. In addition, delegates made excursions to Leningrad and Zaporoshie.

A NOTE ON THE RADIO RESEARCH STATION

On the 20th June 1957 the new, permanent buildings of the Radio Research Station at Ditton Park, Slough, were formally opened by Sir Edward Appleton. Work on the propagation of radio waves started at Ditton Park, on land adjoining the Admiralty Compass Observatory, in 1920, when the Radio Research Board was established by the Department of Scientific and Industrial Research under its first Chairman, Admiral Sir Henry Jackson. The Board, whose present Chairman is Mr. O. W. Humphreys, advises on the programme of work undertaken at Ditton Park. It is also responsible for standards of power and field-strength measurement at frequencies above 300 Mc/s. For many years the Board's standardizing and calibrating work was carried out by the former Radio Division of the National Physical Laboratory, but since 1947 there has been a separate Radio Research Organization in the D.S.I.R., and the work for which the Radio Research Board is responsible is now concentrated at Ditton Park and some small satellite stations in this country and oversea. Until the new buildings were erected, the staff at Ditton Park worked in huts, and some of these have been retained for field experiments.



1 *The new buildings of the Radio Research Station*

The pleasant new buildings, of contemporary design and constructed of brick, pre-stressed concrete and tubular steel, are partially faced with London stock bricks. They comprise a two-storey administration block and a single-storey technical block. In the latter, there are four main laboratories which run out as spurs from a spine unit housing a library, the ionospheric bureau, small test laboratories, etc. The main research at the station is to-day, as it has always been, into problems of radio wave propagation—radio 'pure' (but not simple) as against radio equipment with all its modern ramifications. These problems are of course very tied up with the behaviour of the ionosphere and the effects of solar activity, and much ionospheric work is done; research on direction-finding at various frequencies is also actively pursued. In the standardizing and calibrating field, a new resistive-film method of measuring power at centimetric wavelengths is under development. But as well as the 'pure' radio work, the station has in recent years undertaken a limited amount of research into materials of special interest in the development of radio equipment; some experiments on semi-conductors and ferrites are currently being made. Although many other research laboratories are carrying out work of this kind, the Radio Research Board consider it important that the Radio Research Organization should keep abreast of developments in new radio materials—'the existence of an active research group making its own contribution to the knowledge of the subject is a satisfactory way of achieving this'.

Much work has been done at Ditton Park on ionospheric scattering of radio waves as a means of long-distance point-to-point communication, and attention is now focused on tropospheric scattering at ultra-high frequencies. The radar technique of scatter sounding for displaying on a p.p.i. the effect of the ionosphere on propagation—in particular the skip distance—on various bearings is no longer new, but it is still being improved; equipment similar to that at the Radio Research Station, which has an effective range of some 5 000 km, may be installed at a civil air station to provide first-hand information about short-wave radiocommunication

2 *Investigating the permeability of ferrites at microwave frequencies in the materials research laboratory at Ditton Park*

conditions. In the back-scatter technique, pulses of radio energy on, say, a frequency of 17 Mc/s are sent out at a repetition rate of 25 or 50 a second from a rotating narrow-beam aerial. From those directions where ionospheric reflection takes place and the radio waves reach the ground again, some of the energy scattered by the ground will travel back along the same path to give an echo; communication on 17 Mc/s to the areas from which echoes are received will then be possible.

The ionospheric bureau of the station provides forecasts of ionospheric conditions three to six months ahead, a service which is useful to such organizations as the Post Office, Cable and Wireless, and the B.B.C. It also provides on request daily summaries giving the latest information. The critical frequencies and the heights of the ionospheric layers above Slough are measured daily in the ionospheric observatory by the method of pulse reflection at vertical incidence.

The station is now making many special observations as part of the programme of the International Geophysical Year and its Director, Dr. R. L. Smith-Rose, is the co-ordinator of the British contribution to the ionospheric research programme.

With the radio spectrum becoming more and more congested, research into radio wave propagation—particularly at the higher frequencies—becomes increasingly valuable. Ditton Park is now well equipped to carry out a growing programme of such research, and one may be sure from the past record and the atmosphere of quiet confidence that prevails there that much significant information will flow from its new laboratories. As Sir Edward said in opening the station: '... We must constantly remember this: that, although workers at this station will doubtless be prompted to great exertion by the challenge to their professional skill, there always remains, behind that scientific challenge, the opportunity to benefit civilization. And I do not doubt that, as a result of future work done in and around these new buildings, navigation of all kinds will become surer and safer, and nation will be able to speak to nation with greater certainty and clarity'.

OBITUARY

THOMAS PHILIP EDWARD BUTT

Thomas Philip Edward Butt, who died in 1954, was born at Chichester in 1871. He trained for six years at Devonport Dockyard as an engineer. After working for a further year in the dockyard, he went to South Africa to work as a foreman fitter in the engineering department of a gold-mining company; later he qualified as an electrical engineer at Faraday House and gained a further year of practical experience in a Yorkshire supply company and with Johnson and Phillips. He attained his first responsible position with Siemens and Halske, Charlottenburg, and subsequently went as Assistant Engineer in their power station at Langenthal, Switzerland.

In 1900 he returned to South Africa to take up an appointment as Engineer at one of the Randfontein Group of Mines. When the Boer War broke out in 1901, he joined up with the Searchlight Section. This was the beginning of his success on the Rand. Later, he worked for Sir J. B. Robinson. He designed and constructed the largest private power station in the world (26000 kW). He then installed electrical machinery in twelve mines—the first South African mines to be so equipped. He was General Manager of the Randfontein Estates power station for some years, after which he was appointed Consulting Engineer to the Robinson Group of Companies, Consulting Electrical and Mechanical Engineer to the Barnato Group of Mines, and a member of the Government Commission of Examiners for Electrical and Mechanical Engineers.

He next became Chief Engineer of Trinidad Leaseholds, and in that country he was made a Justice of the Peace. But he returned to South Africa to escape the heat of Trinidad, and in 1924 became a member of the Grain Elevator Commission (Durban).

'Tommie' Butt, as he was affectionately called by his friends at the Rand Club, led a very quiet and happy life, and was deeply loved by his three sons, Val, Guy and Desmond, who ragged him like one of their school friends. He was fond of classical music, was a deep reader and a theosophist, and had excellent health. He travelled to India, Japan and the West Indies, and he also spent some time in Jersey, but he returned to South Africa to retire.

He bought some land at Pinetown for his farmer son, and he himself had a house at Ifafa Beach, for he loved the sea; but when he was over eighty he returned to Pinetown, where, after two years, he died. His widow and two sons survive him.

Mr. Butt joined The Institution in 1898 and was elected an Associate Member in 1900 and a Member in 1908. He was also a Member of The Institution of Mining Engineers. V. G. B.

FRANK CHRISTY

On the 13th May 1957 the death occurred of Frank Christy at his home in Chelmsford. He was born in the same town on the 1st December 1865, and was educated at the Friends' School, Croydon, and Bootham School, York.

In 1882 Mr. Christy was apprenticed to Crompton and Co. of Chelmsford. However, the apprenticeship was somewhat short-lived, as in 1883, encouraged by the late Col. R. E. B. Crompton, whose dynamo was at that time a comparatively new invention, he started business on his own account as an electrical contractor, carrying out his first contract in Ireland. Subsequently he was joined by his brother Leonard, and under the title of Christy Bros. the firm continued with the electrification of mills, factories, public institutions, country houses and villages in all parts of the country, using steam, gas and water power for the prime movers.

The development of water power had the greatest appeal for Mr. Christy. As far back as 1897, he carried out his first hydro-electric scheme for a country house at Dinnet, Aberdeenshire, to be followed by several similar schemes in later years in various parts of the United Kingdom, including one at Leslie in Fife for the Earl of Rothes, and one at Burwash in Sussex for the late Rudyard Kipling. One large installation for a silk factory in Devonshire, which was started about 60 years ago, was remodelled by Mr. Christy as late as 1955, by the installation of more modern and efficient turbines.

In 1900 he started the development of electricity supply undertakings, chiefly in small towns and rural districts. Christy Bros. and Co. were pioneers in this work, which became the most important of their activities. The development of the West Devon Electric Supply Co. gave Mr. Christy his greatest opportunity in hydro-

electric installation, and, with plants at Mary Tavy and Morwellham taking water from the River Tavy, he designed and constructed what he was always pleased to call the largest hydro-electric scheme in England, developing in all some 3300 kW. By his civil engineering work he brought new hope to many people in an area impoverished through the cessation of tin mining.

In 1933 Christy Bros. and Co. became a public company, but, with the nationalization of the electricity supply industry in 1947, the supply activities of the company ceased. Coming at the end of a long and strenuous career, nationalization was a great blow to Mr. Christy. However, undaunted and with his customary vigour, at the age of 82, he successfully accomplished, with the help of some of his colleagues, the task of forming the present company, Christy Bros. Ltd., to continue and extend the manufacturing and contracting side of the former business.

Mr. Christy resigned the Chairmanship of his various companies in 1954 but continued as a Director up to the time of his death, having attended a board meeting as recently as the 27th April.

Apart from business, Mr. Christy was actively interested in the Society of Friends, and missionary and temperance work. Somewhat reserved and unassuming in nature, though formidable in debate, he was nevertheless a man of considerable personal charm, a great optimist, and an outstanding engineer. He was an inspiration to all who came into contact with him. He married Clara Nellie Geaussent on the 13th June 1898, and there were four children of the marriage.

He was a member of the Chelmsford Engineering Society (of which he was President during 1935–36). He joined The Institution as an Associate in 1888 and was elected a Member in 1899. A. A. G.

PERCY GILBERT LEDGER

Percy Gilbert Ledger, B.SC., who died on the 6th October 1956, at St. Phillip's Hospital, Westminster, after a short but painful illness, was born in St. Mary Church, Devon, on the 1st July 1865. He received his early education at a boarding school at Brighton. A year of practical experience with the Brush Electrical Engineering Co. was followed by three years' technical education at Finsbury Technical College from 1883 to 1885. He obtained his engineering degree at London University in 1885, and later joined Siemens Brothers at Woolwich as an assistant engineer; he worked for a brief period on cables and then in the Electric Light Department at a time when the manufacture of dynamo-electric machines was being expanded, mainly for the purpose of lighting.

In 1897 he made a trip round the world with a cousin, and on returning to this country in 1898 he re-entered the service of Siemens Brothers at their London offices, then at Queen Anne's Gate, Westminster. Electrical generating plant was continually increasing in size and capacity, and shortly after the turn of the century Siemens Brothers decided to build a factory at Stafford entirely for this class of manufacture. A new company was formed, Siemens Brothers Dynamo Works, and Mr. Ledger was placed in charge of the department in London, dealing with home and oversea government and shipping contracts, first at York Mansion and then at Caxton House, Westminster. Many important contracts were successfully carried out under his supervision, both before and during the First World War.

Shortly after the close of the war, Mr. Ledger returned to the Woolwich factory of Siemens Brothers on submarine cable work: in 1929 he wrote a paper, with Mr. A. E. Foster and Dr. A. Rosen, on 'The Continuously-Loaded Submarine Telegraph Cable', which was awarded the Fahie Premium by the Council.

In 1933 Mr. Ledger retired from the service of Siemens Brothers, after nearly 45 years with the company. In his years of retirement he kept remarkably fit in body and mind, and was of considerable help to his daughter Margaret, who survives him, on the clerical and bookkeeping side of her duties as an Assistant County Medical Officer of Health.

Kindly and courteous in manner, with a warm regard for children and animals, he was a man of sterling worth and very considerable ability. Tact, technical knowledge and complete reliability were the outstanding features of his business career, and all who came into contact with him both liked and respected him very much.

Mr. Ledger joined The Institution as a Student in 1886 and was elected an Associate in 1887 and a Member in 1906. L. H. C.

GILBERT SMITH

Gilbert Smith, who died on the 27th February 1957, was born at Keighley, Yorkshire, on the 27th December 1892. He was educated at Keighley Grammar School, and, on leaving there, he became a pupil apprentice with the Keighley Electrical Engineering Co., manufacturers of cranes and lifts; during this time he attended evening classes at Keighley Technical Institute and Bradford Technical College and obtained a First Class Pass in the final City and Guilds of London Institute examination in Electrical Engineering and Electrical Machine Design.

During the early part of the 1914–18 War he was an electrician with John Brown and Co., the Clyde shipbuilders, working most of the time on warships. In 1915 he was appointed an assistant electrical design engineer with Herbert Morris Ltd., Loughborough, where he worked for six years. During this time he again attended evening classes, at Loughborough College for two years. After this he became Chief Draughtsman and Electrical Lift Designer with R. A. Evans Ltd at Leicester.

Mr. Smith joined the staff of Loughborough College in 1922 as Electrical Designer and Superintendent of the electrical fitting shop, in which capacity he assisted the late James F. Driver in the layout and erection of the college Diesel-electric power station, and in developing a range of electrical machines and apparatus suitable for laboratories—equipment now giving good service in the laboratories of technical colleges and universities at home and abroad. The Governors of Loughborough College honoured him with the award of the Honorary Diploma of Loughborough College. He became Chief Engineer and Deputy Head of the Works Department of the College in 1943, and for a short time before his retirement in 1954 was Acting Head of the Works Department. He had a wide range of technical interests, and many students and Service men remember with gratitude the help he gave them in lectures and their practical training.

Mr. Smith was modest and likeable; he was fond of rambling, and in recent years of motoring, and he knew well the Yorkshire dales and Charnwood Forest. He leaves a widow and a son.

Mr. Smith joined The Institution as a Graduate in 1917, and was elected an Associate Member in 1921 and a Member in 1948. He served for three years as Joint Honorary Secretary of the East Midland Sub-Centre of The Institution, for four years, until 1950, as Honorary Secretary of the East Midland Centre and for a further two years as an ordinary member of the Centre Committee.

C. A. B.

MAURICE GUSTAVE SCOTCHBURN SWALLOW

Maurice Gustave Scotchburn Swallow, who died in May 1956, at the age of 81, came from a Yorkshire family. He obtained his early education in Vienna, and attended the Technical College at Winterthur in Switzerland from 1891 to 1894 for technical training. After experience with Brown, Boveri and Co of Baden, he came to England in 1901 to join Richardsons, Westgarth and Co., Hartlepool, with whom he was to work initially on a temporary basis, but he remained permanently on the staff and in 1904 was established in the position of Chief of the Land Department. He brought with him experience of work in Italy, France and Spain, together with linguistic accomplishments which later were demonstrated by the translation of an early book on steam turbines from German into English. He remained with Richardsons, Westgarth and Co. until 1943, when he retired.

His association with the engineers in Baden, many of whom were his personal friends, proved of the greatest benefit to his firm at Hartlepool. The content of his technical training as an electrical engineer is discovered by reference to his personal notebook dated 1898, in which will be found many figures of design data and test results for alternators, motors, transformers and the inauguration

of one of the Swiss high-altitude railways. For those who are to-day concerned with electrical apparatus designed only for frequencies of 50 or 60c/s this notebook is of interest; it contains, for example, an efficiency figure of 97·7% for a 100kW transformer designed for frequencies varying from 46 to 70c/s.

Although his earlier activities were in the electrical field, Mr. Swallow was also a mechanical engineer of note and was responsible for the construction of the large steam turbines which were built at Hartlepool and installed in this country. His knowledge of languages resulted in his being a member of the Commission which inspected the engineering establishments in Germany after the armistice in 1918; 23 years later he superintended the construction of the mechanical parts of a supersonic wind tunnel which was installed at the National Physical Laboratory and was used in ballistic research.

During the First World War he was most vigorous in activities supporting the war effort and became a Captain in the local volunteers of the Durham Light Infantry, whilst in the Second World War he held for a time the rank of Major in the Home Guard (Works Company).

Under his guidance the firm at Hartlepool made rapid progress from 1901 onwards in the field of steam turbine plant, and the present position which it occupies in this field of engineering is the best practical tribute which can be paid to his memory and the one which he himself would most have desired and appreciated. At Hartlepool his *modus operandi* was to instil some of his own enthusiasm into his colleagues and the staff under his control; this earned him affection as well as loyalty and elicited the best service from all who came within the orbit of his mind.

Whilst on occasion he could be as firm as anyone, Mr. Swallow never hectored or maintained any grudge, and the permanent impression to which memory bears witness is of a personality which was lively and entertaining, understanding and charming—someone to whom one was always welcome however busy he might be and from whom one parted with regret, having gained inspiration or knowledge or a clearer view about a problem. He established the most pleasant and satisfactory relationships with the men in the shops, and their welfare and interests were his constant preoccupation. If things went wrong he was ready to take responsibility, whilst remaining generous in praise to those who worked with and for him.

His interest in scientific matters was keen and continuous, and he kept in touch with developments in all relevant branches of physics by a close study of technical papers and personal correspondence.

Those who were associated with Mr. Swallow—particularly the younger men—remain permanently in his debt, and to his memory they pay a salute composed of respect, esteem and affection. He is survived by his widow and a daughter.

Mr. Swallow joined The Institution as an Associate in 1898 and was elected a Member in 1922, serving on the Tees-side Sub-Centre Committee 1921–24 and 1926–29. B. B. W.

MONOGRAPHS AND PAPERS

published individually this month

MONOGRAPHS

A New Technique for Evaluating the Response of a Non-Linear Element to Sinusoidal and Random Signals *Monograph* 257 M

J. L. DOUCE, M.SC., PH.D.

A simple method is developed for analysing the response of non-linear elements to sinusoidal and random signals. Special cursors are presented which enable the effective gain of the non-linear unit to be determined quickly.

For sinusoidal signals the technique provides a rapid means for finding the Fourier components of fundamental frequency of the output waveform, for both single-valued and for hysteretic forms of non-linearity. The gain of any single-valued non-linearity when subject to a random signal is also evaluated. The amplitude probability distribution of the signal can be any known function.

Generalized Operators for the Approximate Steady-State Analysis of Linear and Non-Linear Circuits *Monograph* 256 M

A. J. O. CRUICKSHANK, B.SC., PH.D.

A method of approximate analysis is given for linear and non-linear circuits subjected to sinusoidal or non-sinusoidal applied voltages. In brief, the method may be said to be a periodic analogue of the technique of time series. Waveforms are represented by an n-component operator giving the values of the wave at each of n ordinates. For waves containing only odd harmonics, the half-cycle is divided into n parts, while for those containing even harmonics the complete cycle is divided into n parts. The central feature of the method is the use of a shift operator, u, which translates any waveform to the right by $1/n$th of a half-cycle or of a complete cycle as the case may be. The fundamental relations $u^n = -1$ and $u^n = 1$ are obtained in the two cases respectively.

For linear-circuit work the method is advantageous where the periodic input is numerically or graphically specified and where a similar description of the output is required. In the solution of non-linear circuits, e.g. those containing iron-cored coils or non-linear resistors, the current is obtained by a process of continued approximation.

The Design of Automatic-Gain-Control Systems for Auto-Tracking Radar Receivers *Monograph* 258 R

LT.-CMDR. J. C. G. FIELD, R.N., B.SC.

A survey is presented of the automatic-gain-control requirements for target-tracking radars of the conical-scanning type. A simple analysis of linear closed-loop a.g.c. systems is given, from which the required performance can be related to circuit parameters. Practical considerations regarding methods of controlling i.f. amplifier gain, number and position of controlled stages, and means of extracting the conical-scan modulation are briefly reviewed.

The frequency-response characteristics of the a.g.c. loop, as governed by the conflicting requirements of stability, speed of response, and faithful reproduction of the scan modulation, are discussed in relation to the Bode and Nyquist diagrams.

The design methods are illustrated by a description of the development of an a.g.c. system for a particular naval fire-control radar equipment. This system employs suppressor-grid i.f. amplifier control, the control voltage being developed by a special d.c. amplifier.

Target-tracking trials with this system demonstrated that a significant increase in aiming error can normally be produced by fast-acting automatic gain control.

A Contribution to the Theory of Probes in Waveguides *Monograph* 259 R

L. LEWIN

An account is given of some of the difficulties which beset the calculation of the impedance of the finite-size probe in a waveguide. In the particular case of a probe completely spanning a rectangular guide and fed by a coaxial line, a solution is set up in which the line is represented by an arbitrary loading impedance terminating the probe. An integral equation for the current in the probe is solved by a Fourier series in the waveguide modes, and the approximate summation of the double series involved is achieved using Poisson's formula. An expression is derived for the probe impedance from which an equivalent circuit with determinate parameters is obtained. The quasi-static antenna solution is derived as a limiting case for small probe radius, and an interpretation is attempted of the physical significance of the individual terms in the expression for the inductance of an inductive post in a waveguide.

Some Tests on a Stator-Fed Polyphase Shunt Commutator Motor *Monograph* 260 U

C. S. JHA, B.SC.

Based on theory developed in earlier papers equivalent circuits are established for a stator-fed 3-phase shunt commutator motor available for tests. Details are given of methods used in the measurement of equivalent-circuit parameters. The measurement and separation of motor no-load losses are discussed. Test results obtained in no-load and load tests are shown to give fairly good agreement with calculated behaviour.

Outline of a Theory of Non-Uniform Transmission Lines *Monograph* 261 R

BORIS G. KAZANSKY

Complex differential equations relating to non-uniform transmission lines are studied, and the corresponding two-parameter families of solution curves are investigated with the aim of establishing some important properties, e.g. the relationship which exists between the singular points of the differential equation for the normalized impedance and the non-reflective impedances of the corresponding non-uniform line. Because of this relationship it is possible to determine the non-reflective impedances of an arbitrary tapered line by a purely algebraical method and to construct the tangents to the impedance loci at a given point of the impedance plane. Moreover, reflection and transmission coefficients are uniquely determined by the singularities, and differential equations can be readily deduced for these coefficients.

PAPERS

Recent Developments in Medium-Voltage High-Breaking-Capacity Fuse Links *Paper* 2419 U: *Part A*

R. H. DEAN, B.SC.TECH.

The paper reports development work carried out in the investigation of fuse links of ratings up to 600 volts and 600 amp in respect of basic problems of design when compliance with North American specifications and general circuit requirements is sought. Although this work was of a fundamental nature for universal application, it was simulated by the publication of the Canadian Standards Association Code 106. Comparisons are made between this Canadian Code, the 'Standard for Fuses' used in the United States, and current practice in Britain, which centres on B.S. 88: 1952. The results of the high-breaking-capacity tests carried out by the Canadian Standards Association are compared with the calculated figures.

To be read to the South-East Scotland Sub-Centre on the 5th November 1957, to the South-West Scotland Sub-Centre on the 6th November 1957, to the North-Western Utilization Group on the 14th January 1958, and at Savoy Place on the 16th January 1958.

Earthing of Low- and Medium-Voltage Distribution Systems and Equipment *Paper* 2420 S: *Part A*

F. MATHER

The paper states briefly the reasons for earthing low- and medium-voltage distribution systems and equipment. Reference is made to various methods of earthing and to the main difficulties encountered in putting them into practice, particularly in rural areas.

The main objects are to describe the development of the system known as protective multiple earthing, to show the advantages of this system and to explain the reasons for its adoption on a wide scale in the rural zones served by the North Western Electricity Board. The experience of the Board with the p.m.e. system from 1949 onwards is described.

To be read to the South Midland Supply and Utilization Group on the 21st October 1957, and at Savoy Place on the 20th November 1957.

Temperature Transients in Gas-Cooled Thermal Nuclear Reactors *Paper* 2422 M: *Part A*

J. H. BOWEN, B.SC., *and* E. F. O. MASTERS, B.SC.

The paper examines the transient behaviour of the Calder Hall type of reactor in terms of the design and operating parameters, the main transients examined being those arising from: (*a*) step changes in reactivity; (*b*) steady changes in reactivity including the start-up condition; (*c*) step changes in cooling; and (*d*) steady and other changes in cooling due to both circulator-speed and gas-pressure changes.

The examination has been carried out by means of an analogue computer and by a graphical method which employs an approximate solution of the neutron-kinetic equations. The results obtained by the two methods are compared, and agreement is shown to be good.

Due for reading in the second half of the session.

An Accurate Electroluminescent Graphical-Output Unit for a Digital Computer *Paper* 2441 M: *Part B*

T. KILBURN, M.A., PH.D., D.SC., G. R. HOFFMAN, PH.D., B.SC., *and* R. E. HAYES, M.SC.

The paper describes a graphical-output unit fabricated from a uniform layer of electroluminescent phosphor with 512 parallel conducting strips on either side, these respective sets of strips being mutually at right angles to form a matrix of conductors. The application of a changing electric field between selected strips of both sets causes the phosphor to fluoresce at their intersection. As intersections are selected in turn a pattern can be traced out on the panel and recorded photographically. The discrimination ratio of brightness of wanted to unwanted spot positions and an improved method of biasing the matrix are considered in some detail. Other factors, such as driving voltage frequency, waveshape and intermittent operation, are considered as they affect the discrimination ratio.

To be read on the 5th November 1957.

SOME RECENT BOOKS

P. H. G. CRANE
SWITCHGEAR PRINCIPLES

CLEAVER-HUME. 1957. 245 PP. 25S.

This book has been written to provide a general knowledge of switchgear for students and young engineers in the manufacturing and supply industries. In this respect, the author has been particularly successful in the first half of the book, which deals with the more theoretical aspects, e.g. the duty imposed on the circuit-breaker by the system, and the theory of arc interruption. This success is due to the author expressing himself clearly and explaining phenomena in terms of fundamental principles. In the theoretical sections, the treatment is sufficiently comprehensive to make reference to more specialist works unnecessary; thus the treatment of symmetrical components is adequate for the reader who was once conversant with their use, but is not a comprehensive treatment. Conversely, it is doubtful if the average reader would be sufficiently familiar with the nature of system stability to benefit from the author's lucid but necessarily brief explanation—only the consequences of instability and its prevention affect the study of switchgear.

The treatment of oil circuit-breakers is technically sound. It is understandable, but nevertheless to be regretted, that some of the illustrations both of oil circuit-breakers and bushings have been chosen more for illustrating principles than for being representative of modern British practice.

The section dealing with air and air-blast circuit-breakers does not do justice to the growing importance and design problems of circuit-breakers which do not use oil as the interrupting medium. The chapter on switchgear accommodation is essentially sound and the principles are well illustrated. The complexity of modern circuit-breaker testing is clearly explained and put into proper perspective in the final chapter.

This book, with the exceptions referred to, covers the field of switchgear principles very adequately for a first approach to the subject. It should prove a valuable addition to the library of students and those engineers whose interests lie in the use of circuit-breakers rather than in their design.

G. W. A. DUMMER
(1) FIXED CAPACITORS
(2) VARIABLE CAPACITORS AND TRIMMERS

PITMAN. (1) 1956. 270 PP. £2 5S. (2) 1957. 179 PP. 32S. 6D.

These two books form Volumes III and IV of the series on 'Radio and Electronic Components' under the authorship of G. W. A. Dummer, who is responsible for research on and development of such components at the Royal Radar Establishment. The two volumes are a pair in that they are both concerned with the same physical quantity, namely capacitance. The first of them is naturally the larger, since there are more kinds of dielectric used in fixed capacitors than in variable ones. Chapter 1, most of Chapter 2 and a large part of Chapter 3 are identical in the two books. These deal respectively with General Information on Components; General Information on Fixed (or Variable) Capacitors; and the Measurement of Capacitance.

As might be expected from the author's position, much of the subject-matter of Chapters 1 and 2 has been written around the British Joint Services specifications, details of which are listed together with British Standards and some other specialized specifications. The inclusion of such matter, other than in a general form, is open to criticism, since any specification, whatever its source, is always liable to frequent change if it is to be useful.

Chapter 3 comprises a good general survey of capacitance measurement methods, from the early Carey–Foster capacitance bridge, to the later improved forms of a.c. bridges, and to u.h.f. measurements. The remainder of these chapters deals with the measurement of the temperature coefficient of capacitance, and in Volume IV (Variable Capacitors) briefly with the special problems associated with the measurements of very small capacitance changes as required for trimmer capacitor tests.

Chapters 4–8 discuss different types and constructions of capacitors: the fixed capacitors with paper and mica; ceramic, glass and similar dielectrics; plastic film dielectrics; electrolytic constructions and air, vacuum and gas dielectrics; and the variable capacitors of the general-purpose, precision, transmitting, trimmer, and special types. These chapters give but a brief discussion of the various constructions, but they do so in a manner that is adequate to indicate their essential features. The descriptions tend to be confined to the smaller types of capacitor used in telecommunication and electronic engineering.

A chapter in each volume deals with possible faults in capacitors; most of these occur in the small-size capacitors used in electronic apparatus and—especially for variable components—arise directly from the smallness. The next chapter in each book suggests a few future developments, e.g. miniature capacitors to meet the requirements of transistors.

Eighteen pages in Vol. III and ten in Vol. IV are devoted to bibliographies, but naturally many of the references given are the same in each. These are followed in each book by an extensive catalogue of the various market types—running to 78 pages of fixed capacitors and 36 pages of variable capacitors. The catalogue is in tabular form, following the listing format of the Joint Services lists, and gives mechanical dimensions and electrical characteristics. These data are, however, liable to change frequently and at short notice, which may tend to limit the long-term value of the catalogues.

ALAN F. GIBSON and others (*Editors*)
PROGRESS IN SEMICONDUCTORS. VOL. 2

HEYWOOD. 1957. 287 PP. £3 3S.

Since the first volume in this series appeared last year, there has been no falling-off in the number of papers published on semi-conductors and the need for review articles is therefore as great as ever. It can be said at once that the articles contained in this second volume are admirably suited to their purpose. They are written by experts and are comprehensive without being unintelligible to the non-specialist. Furthermore, they are as up to date as it is reasonably possible to make them.

The subjects included are: Semi-conductor Alloys; Properties of the III-V Compound Semi-conductors; Radiation Effects in Semi-conductors; Lifetimes of Free Electrons and Holes in Solids; The Production of High-Quality Germanium Single Crystals; Impurities in Germanium; High Electric Field Effects in Semi-conductors; and Theories of Electro-

luminescence. The emphasis throughout is on physical principles rather than on details, either of mathematical theory or of experimental results, and this gives each article a coherence which it might otherwise lack.

The book will be of great value to anyone interested in semi-conductors.

L. LANDON GOODMAN
MAN AND AUTOMATION

PENGUIN. 1957. 286 PP. 3S. 6D.

The popular interest in automation has resulted in a spate of books on the subject, mostly written for the general reader. As might be expected of a Pelican book, 'Man and Automation', although written by an engineer, is more concerned with the economic and social effects and the implications for trade unions and management than with the technical aspects.

The first part gives a brief historical account of the development of automation and a useful review of the present state of the art in industry and commerce. Space has not allowed a very complete account, but it is certainly adequate to give the general reader a picture of what automation means technically, and there are very few errors.

The second part is without doubt the more important, and Mr. Landon Goodman shows a remarkable insight into social and management problems. Like most engineers he is optimistic about the improvement of working conditions that will result, but not unduly so, and he does not underestimate the importance of dispelling the fear of change that most people have, particularly those who have known unemployment. He quotes Descartes—'Good sense is, of all things among men, the most equally distributed'—and says:

> Clear explanations, a proper display of consideration and courtesy, can do much to bring reason to bear. It is often a long, tedious, and exasperating process, for most men at times can hear only what they wish to hear, and it is always a little more exhausting talking to a deaf person.

This must be taken to heart by all concerned with the introduction of new ideas, since, as the author says, it is the only way to minimize resistance to technical change so that the process may be speeded up for the good of the nation. This is a purely materialistic argument, and the author summarizes the true argument in the words of Walter P. Reuther, President of the Congress of Industrial Organizations in the United States:

> The real measurement of the worth of any free society is the ability of that free society to translate technical progress into human progress, into human happiness, into human dignity.

'A happy individual', says Mr. Landon Goodman, 'is a gain for society; an unhappy individual a loss for society'.

In his conclusion he sums up the position as follows:

> When the whole of industry is considered, it is an outstanding fact that the largest advances in employment have proved to be in those companies where mechanization has been fully and enthusiastically applied. Not only have the employees in those companies benefited, but they have provided goods and services which have enabled their fellow men and women to enjoy a far better standard of living. Only the companies which enthusiastically and sincerely adopt the newest ideas will flourish. The others will fall by the wayside and perish. The real threat to full employment is failure to adopt the benefits of scientific and technological advances. The real threat to civilization is insufficient study of the ways of using the advances made available by scientific study.

This clearly indicates that changes will be necessary at all levels of education, but particularly in technological education, if we are to make the most of the opportunities. Mr. Landon Goodman has a short chapter on technological education which is good as far as it goes, but which could have been extended with advantage. In the chapter on 'Management and Automation', he gives important figures for the number of engineers employed in American industry.

This is a timely book, and the publishers have served a useful purpose in commissioning it. Although it is written for the layman, few engineers who are alive to social problems can fail to profit by reading 'Man and Automation'.

J. HALCOMBE LANING, JR., and RICHARD H. BATTIN
RANDOM PROCESSES IN AUTOMATIC CONTROL

McGRAW-HILL. 1956. 448 PP. £3 15S.

This book is a very able treatise on the mathematics of control systems with random inputs. It is the first book since the one by James, Nichols and Phillips* to deal fully with the optimization of complete systems by analytical methods. Although it is primarily mathematical, some excellent examples are given, mostly taken from the field of gunnery and radar. Methods are given for solving some of the integrals and sets of equations by means of simulators and analogue computers, which should prove to be of value. The early chapters giving the basic concepts of probability theory and of random processes are an excellent exposition of the subject, which should be easily understood by most engineers.

The treatment is longer than some may consider necessary, but this is because a high standard of mathematical rigour has been maintained, and although it results in complete clarity, in some places it makes tedious reading.

This is the first book that deals fully with the analysis of control systems with non-stationary random inputs. The use of adjoint systems with simulator techniques to derive the mean square error may well prove most useful. Non-stationary random processes are handled by treating them as white noise, operated on by linear filters with time-varying parameters—also a useful technique. The development of the mathematics for the synthesis of optimum operations with finite data may well be an important extension of the Wiener optimization procedure, particularly for non-stationary random processes. The somewhat obscure chapter heading 'Optimum Operations with Finite Data' can be interpreted as the optimization of control systems, filters and predictors with random inputs, when the system operates only on a small portion of the input data, defined over a short time interval, instead of being assumed to have operated on the entire past history of the signal and noise data. Unfortunately, the mathematics is exceedingly complicated, and although a computional procedure has been worked out it is very long and is only likely to be used under very special circumstances.

For the mathematician, the whole subject of optimization of control systems with random processes is relatively easy, but the physical implications are difficult; for the engineer, the physical implications are clear, but the mathematics is difficult. It is only now, after nearly fifteen years, that we have simplified the Wiener optimization procedure for linear systems sufficiently to make it usable by practical engineers. The mathematical procedures of 'Random Processes in Automatic Control' are so complicated that there will be very few engineers in this country prepared or able to understand them sufficiently clearly to see the wood for the trees.

This does not detract from the importance of this book at the present time, but it does mean that until simpler methods of use have been worked out by the more theoretically

* JAMES, H. M., NICHOLS, N. B., and PHILLIPS, R. S.: 'Theory of Servomechanisms' (McGraw-Hill, 1947).

minded control engineers, it is unlikely to be of much value to practical designers, and this may not be for many years. Most practising control engineers would be well advised to study the first few chapters and then go to other works, such as 'Engineering Cybernetics' by H. S. Tsien, to get an understanding of the Wiener optimization procedure.

R. K. LIVESLEY

AN INTRODUCTION TO AUTOMATIC DIGITAL COMPUTERS

CAMBRIDGE UNIVERSITY PRESS. 1957. 61 PP. 8S. 6D.

The four chapters into which this small book is divided contain an attempt to explain to practising engineers and to post-graduate students the way in which electronic computers work and how they may be applied to real problems. The author takes the unusual step of starting with the programming of single problems and working from this towards an understanding of the way in which a computer operates.

After this, the second chapter contains a brief account of the various forms of input and output mechanism and of the principal types of storage organ. The third chapter analyses, in greater detail, the considerations which underlie the construction of programmes to solve specific problems; and the final chapter examines the impact of computing machines on the approach that engineers adopt towards their problems.

Naturally, in so short a space, the author has been unable to deal in any detail with real problems, but the examples which he has chosen are good and should encourage the reader to study more specialized publications, some of which are mentioned in a bibliography.

Although the text is rarely provocative, a few of the statements about actual problems require qualification. Two of the more obvious are the remarks on automatic programming (p. 38) and those on linear programming (p. 46). The former seem too pessimistic and the latter rather the reverse. One phrase, however, will reach the hearts of all organizers of computing laboratories; on p. 42 it is stated that the user's attitude 'may vary between blind faith and complete scepticism, according to the standard of reliability of his computer'.

The writing and production are excellent and the only real omission is that of an index—an essential in any technical book, whether an introduction, a textbook, or a reference work. The low price should bring the book within the range of students and thus fill a pressing need.

J. MELLANBY

THE HISTORY OF ELECTRIC WIRING

LONDON: MACDONALD. 1957. 244 PP. 32S. 6D.

The subject of electric wiring and accessories is one which, as the author rightly points out, has received comparatively little attention from writers on the subject of engineering history. It is probable that two equally valid reasons can be advanced to explain this apparent neglect. First, notwithstanding the unquestionable importance of accessories in any electrical installation, there is, in general, little about them to attract the attention of those inclined towards theory and research, and secondly, the general form of many accessories in use to-day would be familiar to a wireman of sixty years ago. To take a few examples: the bayonet cap, used on English lamps, was patented with the first switched lampholder as long ago as 1882. The equally well-known screw-pattern fitting was first used by Edison in 1879 and has undergone little fundamental alteration beyond the substitution of more modern materials. In turning over the pages of this book, the reader will find that the tumbler switch dates from 1890 and that round-pin plugs and sockets were in use rather earlier than this.

There have, of course, been many important changes in detail which the author discusses, and his references to contemporary prices are noteworthy. Perhaps the most valuable part of Mr. Mellanby's interesting book is to be found in those chapters dealing with the pre-history of the wiring accessories. Here the reader may well meet for the first time the name of Mr. Musgrave Heaphy, the enlightened engineer of the Phoenix Assurance Co. who in his executive capacity made what is probably the greatest individual contribution towards safety of electrical installations generally. The Phoenix Rules were first published in 1882, in which year also appeared the first edition of the 'Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting', published by The Institution, then the Society of Telegraph Engineers and of Electricians.

If this book does no more than revive the name of an eminent pioneer largely forgotten to-day, the author will have justified the maxim of all true historians—*magna est veritas et praevalebit*.

Mr. Mellanby seems to be on less sure ground when he leaves the main topic of his book and refers to machines. Surely Kelvin *did* patent the so-called ribbon armature and illustrated it in his voluminous Specification No. 5668 of 1881; and was it not Sir William Siemens who first made use of the contraction 'dynamo'? But these are minor criticisms of a useful and authoritative work.

A. G. MILNES

TRANSDUCTORS AND MAGNETIC AMPLIFIERS

LONDON: MACMILLAN. 1957. 300 PP. £3 3S.

Dr. Milnes's book on magnetic amplifiers is based largely on a number of papers which he has published during the last ten years. Over this period the industrial applications for these devices have increased rapidly, and the author has contributed much to the theoretical and practical aspects of the subject. The reader may therefore be a little disappointed to find that the problem of design has not been given as much attention as would be expected in a book of this standard.

On the whole however the book is clearly written. The first six chapters deal admirably with the theory of the single-phase transductor with resistive, capacitive and inductive loads. A very fine account of push-pull operation is followed by a detailed treatment of 3-phase transductors. Chapter Ten describes some typical applications, rightly concentrating on servo and control equipment. The last three chapters fail to maintain the standard found elsewhere in the book and tend to give the impression that they have been added as an afterthought. It is a pity that the even-harmonic amplifiers and the fast-response transductors should be in this category.

Nevertheless the book stands as one of the authoritative works on magnetic amplifiers. It will appeal to all engineers who wish to acquire considerably more than a superficial knowledge of the subject, and for such readers it represents good value even at a price of three guineas.

The book is well produced: the type is large and generously spaced and the mathematical printing is, apart from one or two lapses, admirable. It is a pleasure to handle a book of this kind in a quarto size, and the general appearance is satisfying, though the illustrations are rather uneven in size and lettering.

Forthcoming Events at Savoy Place

All meetings are held at Savoy Place, beginning at 5.30 p.m. (tea at 5 p.m.), except where otherwise stated. The nature of the meeting is indicated by the following key:

E EDUCATION DISCUSSION CIRCLE
I INFORMAL
M MEASUREMENT AND CONTROL SECTION
O ORDINARY
R RADIO AND TELECOMMUNICATION SECTION
S SUPPLY SECTION
U UTILIZATION SECTION

After each paper that has now been published is added the month that a synopsis has appeared in the *Journal* under 'Monographs and Papers published individually this month', i.e. about the time the paper has been published as a separate. A paper that has not yet been published will be available at least ten days before the meeting at which it will be read.

October 1957

R **16** *Wednesday* J. S. McPETRIE, PH.D., D.SC. Chairman's Address 'Some Radio Aids for High-Speed Aircraft'‡

E **18** *Friday* H. E. DANCE, M.ENG., *and* P. F. SOPER, PH.D.(ENG.), B.SC.(ENG.) will open a discussion on 'The Architectural Features of Electrical Engineering Laboratories' before the Education Discussion Circle* (At 6 p.m., tea at 5.30 p.m.)

M **22** *Tuesday* G. W. BOWDLER, M.SC. Lecture on 'The Measurement of High Voltages with Indicating or Recording Instruments'†

S **23** *Wednesday* PROFESSOR M. G. SAY, PH.D., M.SC. Chairman's Address 'Too Much and Too Little'‡

U **24** *Thursday* J. PODOSKI Informal Lecture on 'The Post-War Electrification of the Polish State Railways'†

R **28** *Monday* Informal Evening on 'Domestic High-Fidelity Reproduction', at which there will be a talk given by J. MOIR†

November 1957

M **5** *Tuesday* M. V. WILKES, M.A., PH.D., F.R.S., W. RENWICK, M.A., B.SC., *and* D. J. WHEELER, PH.D. 'The Design of the Control Unit of an Electronic Digital Computer' (Paper No. 2365 M) *Synopsis:* June 1957

M. A. MACLEAN, M.SC., *and* D. ASPINALL, B.SC. 'A Decimal Adder using a Stored Addition Table' (Paper No. 2389 M) *Synopsis:* July 1957

T. KILBURN, M.A., PH.D., D.SC., G. R. HOFFMAN, PH.D., B.SC., *and* R. E. HAYES, M.SC. 'An Accurate Electroluminescent Graphical Output Unit for a Digital Computer' (Paper No. 2441) *Synopsis:* see p. 552.

O **7** *Thursday* Discussion of the Report entitled 'The Supply and Training of Teachers for Technical Colleges'†

(This Report, of a special Committee appointed by the Minister of Education, will be introduced by WILLIS JACKSON, D.SC., D.PHIL., DR.SC.TECH., F.R.S., Chairman of the Committee. Copies are obtainable from H.M. Stationery Office, price 4s.).

I **11** *Monday* D. J. BOLTON, M.SC.(ENG.) will open a discussion on 'Ought Electricity to be used for Space Heating in Domestic Premises?'*

M **12** *Tuesday* Section Dinner (at the Café Royal).

R **13** *Wednesday* J. M. C. DUKES, M.A. 'The Application of Printed-Circuit Techniques to the Design of Microwave Components' (Paper No. 2401 R) *Synopsis:* August 1957. 'Broad-Band Slot-Coupled Microstrip Directional Couplers' (Paper No. 2402 R) *Synopsis:* August 1957. 'Re-entrant Transmission-Line Filter using Printed Conductors'

U **14** *Thursday* L. ABRAM, B.SC.(ENG.), J. B. McBREEN *and* J. SHERLOCK, B.SC.(ENG.) 'D.C. Winder Drives using Mercury-Arc Rectifier/Inverters' (Paper No. 2324 U) *Synopsis:* February 1957

MU **19** *Tuesday* J. M. LAYTON, V. N. MANOHAR *and* R. A. STEVENS will open a discussion on 'The Measurement of the Dynamic Characteristics of Electrical Machines'†

S **20** *Wednesday* F. MATHER 'Earthing of Low- and Medium-Voltage Distribution Systems and Equipment' (Paper No. 2420 S) *Synopsis:* see p. 552

E **21** *Thursday* PROFESSOR E. BRADSHAW, M.B.E., M.SC.TECH., PH.D., will open a discussion on 'High-Voltage Experiments' before the Education Discussion Circle* (At 6 p.m., tea at 5.30 p.m.)

R **25** *Monday* Informal Evening on 'Problems of Sound and Television Broadcasting Coverage', at which there will be a talk given by G. MILLINGTON, M.A., B.SC.†

O **28** *Thursday* W. A. SHARPLEY *and* J. V. OLDFIELD, B.SC.(ENG.) 'The Digital Computer applied to the Design of Large Power Transformers' (Paper No. 2404 S) *Synopsis:* August 1957

December 1957

MR **3** *Tuesday* G. M. ETTINGER, B.SC.(ENG.), M.SC.(ENG.) 'Some Aspects of Half-Wave Magnetic Amplifiers' (Paper No. 2353 M) *Synopsis:* April 1957

G. B. B. CHAPLIN, M.SC., PH.D., *and* A. R. OWENS, M.SC. 'Some Transistor Input Stages for High-Gain D.C. Amplifiers' *and* 'A Transistor High-Gain Chopper-Type D.C. Amplifier' (Paper No. 2382 M) *Synopsis:* July 1957

G. B. B. CHAPLIN, M.SC., PH.D., *and* R. WILLIAMSON 'Dekatrons and Electro-Mechanical Registers operated by Transistors'

O **5** *Thursday* (In conjunction with the British Nuclear Energy Conference) J. V. DUNWORTH, C.B.E., M.A., PH.D. Lecture on 'Advanced Types of Power Reactors'‡

I 9 *Monday* K. J. R. WILKINSON, D.SC., will open a discussion on 'Where Should Research End and Development Start?'*

R 11 *Wednesday* H. E. HOLMAN, G. C. NEWTON *and* S. F. QUINN 'A Flying-Spot Film Scanner for Colour Television' (Paper No. 2390 R) *Synopsis:* June 1957

UR 12 *Thursday* F. BENTHAM 'Electrical Control of Stage and Television Lighting' (Paper No. 2424 U)

E 13 *Friday* W. CHELLINGSWORTH, B.SC.(ENG.) will open a discussion on 'Basic Experiments on Servo Mechanisms' before the Education Discussion Circle* (At 6 p.m., tea at 5.30 p.m.)

R 16 *Monday* Informal Evening on 'Electronics and Automation—Electronics in the Textile Industry' at which there will be a talk given by K. J. BUTLER†

17 *Tuesday* SIR EWART SMITH, M.A. Fourth Graham Clark Lecture on 'The Engineer and Management'‡ (Joint Meeting with The Institutions of Civil and of Mechanical Engineers at The Institution of Civil Engineers, Great George Street, Westminster, S.W.1)

M 17 *Tuesday* J. LAMB, PH.D., M.SC. Informal Lecture on 'Recent Uses of Ultrasonics in Investigating the Characteristics of Materials'†

S 18 *Wednesday* J. PIMPANEAU. Informal Lecture on 'The Planning and Construction of Large Modern Thermal Generating Stations' followed by a discussion† (Joint Meeting with the British Section of the Société des Ingénieurs Civils de France)

* No advance information will be available and no Press report will be permitted.
† An abstract will be available in advance.
‡ No advance information will be available.

LIBRARY ACCESSIONS

BOOKS

PAST STUDENTS' ASSOCIATION OF LOUGHBOROUGH COLLEGE 93:06

The History of Loughborough College 1915–1952

Loughborough, Past Students' Association, 1957. pp. xi, 172. 24 × 17 cm.

SMOLIŃSKI, A. 621.395.645

Zasady Wzmacniania (Fundamentals of Amplification)

Warsaw, Panstowe Wydawnictwa Techniczne. Vol. I, 2nd ed., 1950. pp. xvi, 274. 20 × 14 cm. Vol. II, 2nd ed., 1956. pp. 322. 25 × 17 cm. Vol. III, 1956. pp. 536. 25 × 17 cm.

Vol. I introduces the linear theory, describes the types of amplifier and discusses their practical operation. The other volumes treat various voltage amplifiers, citing original work done at the Warsaw Technical University. A fourth volume may be published later.

OTHER PUBLICATIONS

CENTRAL YOUTH EMPLOYMENT EXECUTIVE

The Electrician

London, H.M.S.O., 1957. Choice of Careers, New Series No. 79. pp. 36. 22 × 14 cm. 1s. 9d.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Radio Research 1956. The Report of the Radio Research Board and the Report of the Director of Radio Research

London, H.M.S.O., 1957. pp. iv, 47. 24 × 15 cm. 3s.

FEDERAL POWER COMMISSION

Statistics of Electric Utilities in the United States 1954. Classes A and B Publicly Owned Systems

Washington, Federal Power Commission, 1956. pp. xvii, 105. 29 × 23 cm. 14s.

Statistics of Electric Utilities in the United States 1955. Classes A and B Privately Owned Companies

Washington, Federal Power Commission, 1956. pp. xxxiv, 705. 29 × 23 cm. £2 2s.

HEINRICH, R. F., and ANDERSON, J. R.

Electro-Precipitation. A Reprint from Chemical Engineering Practice Vol. 3

London, Butterworths, 1957. pp. 50. 25 × 16 cm.

HIS ROYAL HIGHNESS THE DUKE OF EDINBURGH'S STUDY CONFERENCE ON THE HUMAN PROBLEMS OF INDUSTRIAL COMMUNITIES WITHIN THE COMMONWEALTH AND EMPIRE OXFORD 1956

Vol. I. Report and Proceedings

London, Oxford University Press, 1957. pp. xii, 338. 25 × 16 cm.

Vol. II. Background Papers. Appendixes and Index

London, Oxford University Press, 1957. pp. xv, 339. 25 × 16 cm. £2 2s. (2 vols.).

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

Annual Report of the Conference on Electrical Insulation 1956 Meeting

Washington, National Academy of Sciences—National Research Council, 1957. pp. xi, 64. 28 × 21 cm. 24s.

NATIONAL PHYSICAL LABORATORY—DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL SCIENCE

Modern Computing Methods. Notes on Applied Science No. 16

London, H.M.S.O., 1957. pp. vi, 128. 24 × 15 cm. 10s. 6d.

PHYSICAL SOCIETY

Report of the Meeting on Semiconductors held by the Physical Society in Collaboration with British Thomson-Houston Ltd., Rugby, in April 1956

London, Physical Society, 1957. pp. 153. 24·5 × 16 cm. 12s. 6d.

District Meetings

Arrangements for District Meetings in October and November other than those in the area of a Local Centre.

October 1957

READING (At the George Hotel, King Street, Reading, at 7.15 p.m.)

21 *Monday* A. ABBOTT 'A Historical Survey of the Development of Switchgear'

November 1957

MAIDSTONE (At the Medway College of Technology, Maidstone Road, Chatham, at 6.30 for 7 p.m.)

4 *Monday* A. O. JOHNSON, B.SC.TECH., *and* N. F. MARSH, M.A. 'The Standardization of Retail Electricity Tariffs'

OXFORD (At the Demonstration Room, Southern Electricity Board, 37 George Street, Oxford, at 7 p.m.)

13 *Wednesday* E. L. E. WHEATCROFT, M.A., *and* H. H. C. BARTON, B.A. 'The Potentialities of Railway Electrification at the Standard Frequency'

READING (At the George Hotel, King Street, Reading, at 7.15 p.m.)

25 *Monday* J. H. GOSDEN, B.SC. 'Cathodic Protection'

British Nuclear Energy Conference: Forthcoming Programme

Forthcoming meetings of the British Nuclear Energy Conference are listed in the programme below. Unless otherwise stated, the following particulars hold for them: they take the form of the presentation and discussion of one or more papers; they are held at 5.30 p.m., with tea at 5 p.m.; and tickets of admission are not required.

Where available, a synopsis of a paper is provided below the details of the title and author. Advance copies of papers can usually be obtained from the Secretary of the sponsoring society, not from the Secretary of the British Nuclear Energy Conference.

NOVEMBER 8 *Friday*

Sponsoring society and place of meeting: The Institution of Mechanical Engineers, 1 Birdcage Walk, S.W.1.

VACUUM TECHNIQUES IN THE ATOMIC ENERGY INDUSTRY
Dr. H. Kronberger

For synopsis, see September *Journal*, p. 526.

DECEMBER 5 *Thursday*

Sponsoring society and place of meeting: The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

A lecture on ADVANCED TYPES OF POWER REACTOR
J. V. Dunworth, C.B.E., M.A., PH.D.

No advance information will be available.

Contents of the Current Issues of the *Proceedings*

The date in italics is that of the Journal review or special article. Where given, the date in small capitals refers to the month in which a paper was published individually.

PART A. POWER ENGINEERING (OCTOBER 1957)

H. B. CALVERLEY, B.SC.(ENG.), E. A. K. JARVIS, B.SC.(ENG.), AND E. WILLIAMS, B.SC.(ENG.). PAPER NO. 2339 U, MARCH 1957
Electrical Equipment for Rectifier Locomotives *June 1957*

Discussion on **Flat Pressure Cable** before the Western Centre and the Southern Centre

Discussion on **The Potentialities of Railway Electrification at the Standard Frequency** before the Southern Centre, the North Staffordshire Sub-Centre, the South Midland Centre, the East Midland Centre, the Western Centre, the Sheffield Sub-Centre, the Northern Ireland Centre, the South-East Scotland Sub-Centre, the Mersey and North Wales Centre and the North Midland Centre

J. D. HUMPHRIES, B.SC.(ENG.). PAPER NO. 2341 S, MARCH 1957
Earth-Electrode Systems for Large Electric Stations *October 1957*

Discussion on **Electrical Energy from the Wind** before the South Midland Supply and Utilization Group

E. R. HARTILL, B.SC.(ENG.), J. G. MCQUEEN, AND P. N. ROBSON, B.A. PAPER NO. 2179 M, OCTOBER 1956
A Deep Electrolytic Tank for the Solution of 2- and 3-Dimensional Field Problems in Engineering *July 1957*

Discussion on **Resistance Heating of Mild-Steel Containers at Power Frequencies** before the Mersey and North Wales Centre

Discussion on **Timing the Operation of Control Systems associated with Rotating Equipment** before the Western Utilization Group

E. BATES. PAPER NO. 2284 U, FEBRUARY 1957
Development of Transportable Thermal-Storage Space Heaters *July 1957*

J. W. MOULE, B.SC.(ENG.), AND W. M. STEVENSON, T.D. PAPER NO. 2330 U, FEBRUARY 1957
Electrical Floor Warming *July 1957*

Discussion on **Some Aspects of Heat Pump Operation in Great Britain** before the Southern Centre

O. W. HUMPHREYS, C.B.E., B.SC., AND R. SMITH, B.SC. PAPER NO. 2409
Electrical Process Heating (*Review of Progress*) *October 1957*

PART B. RADIO AND ELECTRONIC ENGINEERING (SEPTEMBER 1957)

See the issue for September 1957, p. 525

PART C. MONOGRAPHS (SEPTEMBER 1957)

See the issue for September 1957, p. 525

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 25TH SEPTEMBER 1957

	No. of Contributors	£	*s.*	*d.*
£1 000 and over	6	6 000	0	0
£100 to <£1 000	30	6 586	3	0
£5 to <£100	835	8 884	12	1
£2 to <£5	2 013	5 506	19	11
Under £2	21 972	11 486	2	9
		£38 463	17	9

APPOINTMENTS AND NOMINATIONS

COMMITTEE ON REGULATIONS FOR THE ELECTRICAL EQUIPMENT OF BUILDINGS

On the nomination of the War Office, the Council have appointed Major A. S. Crawford to serve on the above Committee, in place of Major P. H. D. R. Beckett.

COMMITTEE ON RADIO EQUIPMENT FOR CIVIL AIRCRAFT

On the nomination of the Air Registration Board, the Council have appointed Mr. K. W. B. Fouweather to serve on the above Committee, in place of Mr. L. A. Hancox.

On the nomination of the Radio Communication and Electronic Engineering Association, the Council have appointed Mr. D. A. Beresford, ASSOCIATE MEMBER, and Mr. H. Holmes to serve on the above Committee, in place of Mr. N. G. Anslow and Mr. R. L. Stride.

On the nomination of the Royal Aeronautical Society, the Council have appointed Mr. J. M. Furnival, M.B.E., F.R.AE.S., to serve on the above Committee, in place of Mr. C. H. Jackson.

BRITISH STANDARDS INSTITUTION

B.S.I. Sub-Committee ELE/3/19—Fittings for Mineral-Insulated Cables

The Council have nominated Mr. G. Auterson, B.SC., ASSOCIATE MEMBER, and Mr. J. S. McCulloch, ASSOCIATE, to serve as their representatives on the above Sub-Committee.

B.S.I. Sub-Committee ELE/3/24—Cables and Lifts

The Council have nominated Mr. C. E. Mills, MEMBER, to serve as their representative on the above Sub-Committee.

B.S.I. Sub-Committee MEE/149/4—Magnetic Tape for Use with Computers

The Council have nominated Dr. G. A. V. Sowter, B.SC.(ENG.), MEMBER, to serve as their representative on the above Sub-Committee.

BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

The Council have nominated Dr. D. Taylor, M.SC., MEMBER, to serve as their representative on the Council of the above Association.

SCHOLARSHIPS

The following scholarships have been awarded by the Council for 1957:

RESEARCH SCHOLARSHIPS

I.M.E.A. Scholarship (*Value £420, for one year*)

* T. C. DENTON, who is to continue his research into the ultrasonic properties of solids in the frequency range 30–500 kc/s at the Imperial College of Science and Technology.

Oliver Lodge Scholarship (*Value £420, for one year*)

W. A. CHARLESON, to enable him to pursue research in solid-state electronics at the Heriot-Watt College, Edinburgh.

Swan Memorial Scholarship (*Value £300, for one year*)

R. SPENCE, who is to undertake research on transistor sinusoidal oscillators and their synchronization to injected signals at the Imperial College of Science and Technology.

The C.P. Sparks War Thanksgiving Fund (*Value £100*)

N. E. WISEMAN, who is to undertake research in digital computer engineering at the Graduate College, University of Illinois.

GRADUATE SCHOLARSHIPS

Duddell Scholarship (*Value £400, for one year*)

R. H. OGBORN, who will attend a post-graduate course of study at the Imperial College of Science and Technology.

Silvanus Thompson Scholarship (*Value £400, for one year*)

K. B. YOUNG, who will undertake post-graduate studies into the analysis of on/off servo mechanisms at the University of Cambridge.

STUDENT SCHOLARSHIPS

Sir Arthur Fleming Scholarship (*Annual value £120; tenable for four years*)

P. G. BICKERTON, who will attend a sandwich course for the award of the Dip.Tech.(Eng.).

Paul Scholarship (*Value £150 for one year*)

D. W. PRITTY, who is in the final year of the honours degree course in electrical engineering at the University of Glasgow.

Salomons Scholarship (*Value £60 for one year*)

J. P. BENNETT, who is in the final year of the honours degree course in electrical engineering at the University of Nottingham.

Sir Charles A. Parsons Memorial Scholarship (*Annual value £60, for three years*)

G. C. SHERING, who is in the first year of the honours degree course in electrical engineering at the University of Edinburgh.

Thorrowgood Scholarship (*Value £25, for one year*)

G. A. H. GADBURY, who is attending the Higher National Certificate course in electrical engineering at the West Ham College of Technology.

D. E. REYNOLDSON, who is a student at the South East Essex Technical College, Dagenham.

Knight Fund (*Value £60, for one year*)

G. K. THOMAS, who is attending the Higher National Diploma course at the Glamorgan Technical College.

* Renewal of award made in 1956

ARTICLES IN THE TECHNICAL PRESS

To enable the technical Press to publish as soon as possible new material of topical interest dealt with in papers accepted for reading before The Institution, an author of such a paper is at liberty to offer a more popular, less technical and shorter article for publication in the technical Press before the reading of his formal Institution paper on the same subject, provided that the article does not appear before the paper has been published individually and that the article makes reference to the paper.

Similarly, the author of a paper which has been accepted for publication only may proceed forthwith to prepare an article for the technical Press, but it must not appear before the paper has been published in the *Proceedings* or as a *Monograph*, and it must be accompanied by a suitable acknowledgment.

ARRANGEMENTS WITH ENGINEERING INSTITUTIONS OVERSEA

Members who may have to travel abroad are reminded that in certain countries reciprocal arrangements are in operation for the extension of privileges to visiting members. The complete list of Institutions concerned is now as follows:

Country	*Institution*
Australia	Institution of Engineers, Australia.
Austria	Österreichischer Ingenieur- und Architekten-Verein.
Belgium	Société Royale Belge des Ingénieurs et des Industriels.
	Société Belge des Électriciens.
Brazil	Instituto de Engenharia, São Paulo.
Canada	Engineering Institute of Canada.
Denmark	Dansk Ingeniørforening.
Finland	Suomen Teknillen, Seura.
	Tekniska Föreningen i Finland.
France	Société des Ingénieurs Civils de France.
	Société Française des Électriciens.
Germany	Verein Deutscher Ingenieure.
	Verband Deutscher Elektrotechniker.
Holland	Koninklijk Instituut van Ingenieurs.
Iceland	Association of Chartered Engineers in Iceland.
India	Institution of Engineers, India.
Italy	Associazione Elettrotecnica Italiana.
Japan	Institute of Electrical Engineers of Japan.
New Zealand	New Zealand Institution of Engineers.
Norway	Norsk Elektroteknisk Forening.
	Norsk Ingeniørforening.
Rhodesia	Rhodesian Institution of Engineers.
South Africa	South African Institution of Civil Engineers.
	South African Institute of Electrical Engineers.
	South African Institution of Mechanical Engineers
Sweden	Svenska Teknologföreningen.
Switzerland	Schweizerischer Ingenieur- und Architekten-Verein.
Turkey	Turkish Engineering Society.
United States	American Institute of Electrical Engineers.
	American Institute of Chemical Engineers.
	American Institute of Mining and Metallurgical Engineers.
	American Society of Civil Engineers.
	American Society of Mechanical Engineers.
	Institute of Radio Engineers.

The Secretary will gladly give letters of introduction to members visiting these countries.

PROCEEDINGS, PARTS A, B AND C

The Council regret that circumstances compel them to increase the charges made to members and to the general public for each of the three parts of the *Proceedings* of The Institution. Since the present rates were fixed there have been substantial increases in all printing costs and two heavy increases in postage charges; the second of these, effective from the 1st October 1957, has made further postponement of a revision of the scale of charges impossible. From the 1st January 1958, the annual subscription rates will be as follows (the figures in brackets are the present rates):

	For all members other than Graduates and Students up to the age of 28	Graduates and Students up to the age of 28
Proceedings, Part A	15s. (10s.)	7s. 6d. (5s.)
Proceedings, Part B	15s. (10s.)	7s. 6d. (5s.)
Proceedings, Part C	7s. 6d. (5s.)	5s. (2s. 6d.)
Combined subscription for Parts A, B and C	£1 15s. (£1 2s. 6d.)	18s. 6d. (12s.)

Note: The new rates payable by non-members will be £2 10s. each for Parts A and B, £1 5s. for Part C, and £2 for the *Journal*. A combined subscription for all four publications will be £8.

Each member who is at present paying his subscription by means of a banker's order will shortly receive a new order form so that he may revise the instructions to his bank.

FIRST INTERNATIONAL CONGRESS ON VACUUM TECHNIQUES

BRUSSELS: JUNE 1958

The First International Congress on Vacuum Techniques, officially sponsored by the Belgian Government in connection with the Brussels 1958 Exhibition, will be held in Namur from the 10th to 13th June 1958. The main subjects to be covered are: a scientific foundation of vacuum techniques; production and measurement of high and ultra-high vacua; and applications of vacuum techniques in industry.

Those wishing to attend the Congress or obtain further information should write to Professor E. Thomas, c/o CSN/ERM, 30 Avenue de la Renaissance, Brussels 4, Belgium.

RUSSIAN HYDRO-ELECTRIC DEVELOPMENTS

THE REPORT OF A DELEGATION TO THE U.S.S.R.

In October 1956, a delegation, consisting of a group of six engineers, was appointed by the Institutions of Civil, Mechanical, and Electrical Engineers, in association with the Soviet Relations Committee and the British Council, to visit the U.S.S.R. for the purpose of studying hydro-electric developments in that country. The report of the delegates was discussed at a Joint Meeting of the three Institutions on the 20th May 1957.

Copies of the report and the discussion of it are now available from the Secretary, The Institution of Civil Engineers, Great George Street, London, S.W.1. The price is 5s. to a member of one of the three Institutions, and 12s. 6d. to non-members.

APPOINTMENTS IN THE E.R.A.

The Director of the Electrical Research Association, Dr. H. G. Taylor, MEMBER, F.INST.P., has announced that the Association has appointed Mr. L. Gosland, B.SC., MEMBER, as Research Manager, and Mr. E. E. Hutchings, B.SC.(ENG.), MEMBER, as Head of the Member Relations Department. Mr. A. M. Cassie, M.A., B.SC., MEMBER, and Dr. L. H. Orton are appointed Joint Heads of the Switchgear Department, and Dr. G. Mole and Dr. F. Busemann, ASSOCIATE MEMBER, Head and Deputy Head, respectively, of the Transmission and Utilization Department.

I.E.C. CODE ON ELECTRICAL INSTALLATIONS IN SHIPS

The announcement about the new I.E.C. Code on Electrical Installations in Ships on p. 516 of the September issue of the *Journal* may be misleading in that it implies that this Code may sometime become the standard international set of regulations for such installations and that The Institution would then withdraw its own Regulations for the Electrical Equipment of Ships. In fact, there is no likelihood of this development occurring in the foreseeable future, and The Institution, as stated in the Annual Report for last year, is at present actively engaged on the preparation of a Fourth Edition of the Ships Regulations. The I.E.C. Code, in common with all I.E.C. publications of this kind, takes the form of recommendations for international use, for adoption if thought fit by the national committees as the basis for their own national regulations.

The price of the new I.E.C. Code was also stated incorrectly under 'Library Accessions' on p. 475 of the August issue of the *Journal*. The price given in the announcement in the September issue is correct, namely £2 2s., post free.

NEWS *from Abroad*

BRISBANE

QUEENSLAND OVERSEA COMMITTEE

First-Hand Account

At the invitation of The Institution of Engineers, Australia, Brisbane Division, a number of our members attended a lecture given by Mr. A. McCulloch, Chief Engineer of the Southern Electric Authority of Queensland. The meeting was under the chairmanship of Professor Mansergh Shaw, who introduced the speaker.

Mr. McCulloch based his lecture on observations made during his recently completed oversea trip, which took him mainly to the United Kingdom but also to the Continent of Europe.

The main theme of the talk was the development of nuclear power for the generation of electricity. Mr. McCulloch introduced many of the new terms that have come into being in connection with nuclear developments. He traced briefly the system of operation adopted at Calder Hall and went on to explain how the lessons learned in this station were being applied to a further four atomic stations at present under construction, or consideration, for the Central Electricity Authority.

Although the major portion of Mr. McCulloch's talk related to nuclear power stations, he did find time for a brief reference to steam conditions. He also made a comparison between Calder Hall and those power stations which might operate with fast reactors, and he gave an outline of the reasons why the Calder Hall type of station had been selected for use in the British Isles.

The lecture was extremely well attended by a good cross-section of the engineering profession. At the conclusion of the lecture, a vote of thanks was proposed by Mr. Rivett and supported by Mr. Lohning. W. I. G.

HONG KONG

HONG KONG JOINT OVERSEA GROUP

Dams and Airports

Early in the 1956–57 Session Mr. A. P. Goudy presented his very interesting and topical paper entitled *Concrete Arch Dams* to a large audience of seventy members and guests.

We were also fortunate in having Mr. J. K. M. Henry with us to offer for discussion the paper entitled *The Planning and Design of the New Hong Kong Airport*, which was recently read before The Institution of Civil Engineers in London by his co-author, Mr. H. Grace. A film illustrating the paper was shown. Eighty members and guests signed the register. This latter meeting was preceded by a visit to the airport site at Kai Tak, at the kind invitation of the Chief Resident Engineer of the development scheme. A party of over 100 members and guests enjoyed this very interesting visit.

The 1956–57 Session was therefore a satisfactory one, particularly for those members who are civil engineers.

Next session it is hoped to be able to add a little variety, and it would be particularly gratifying to the Committee if some of the younger members of the three Institutions, especially the Graduates and Students, could provide us with some short papers describing the work upon which they are engaged.

IRAQ

IRAQ AND PERSIAN GULF JOINT OVERSEA GROUP

A.G.M. and Cruise

On the 4th April the Iraq and Persian Gulf Joint Oversea Group held its fifth Annual General Meeting at the Shatt-al-Arab Hotel in Basra. Mr. J. D. Addison, Chairman, reported on the very successful session now closing, and Capt. J. M. Morris, 'father' of the Group, was elected Chairman for the ensuing year.

At the ordinary meeting which followed, Mr. C. A. Gillott, read a very informative paper on *Strengthening the Tansa Dam* (*Bombay Municipality*), which explained how the ideas inherent in prestressed concrete practice were applied to tie a masonry dam down to bedrock (the Coyne method). The paper was illustrated by a film and followed by a lively discussion.

On the following day members with their guests and ladies, some thirty-six in all, were indebted to His Excellency Sami Fattah Pasha, Director-General of the Iraqi Ports Administration, for an excellently arranged trip by launch from the jetties at Margil and the loading berths at Ashar down the Shatt-al-Arab for some thirty miles past the Persian port and naval base at Khurramshahr and the refinery and tanker-loading installations at Abadan to the intermediate pilotage station at Harmaq. In this climate, the temperament of the Clerk of the Weather is more consistent than in Britain; even so, he was generous and gave a memorable finish to a memorable year's activities. J. A. C. K.

NEWS *from the Centres: Summer Meetings*

MERSEY AND NORTH WALES CENTRE

The Annual Summer Meeting of the Mersey and North Wales Centre was held on Saturday, 15th June, when a party of 200, comprising members with ladies and friends, visited Calder Hall.

Groups of about twelve were conducted through the power station, which provided many features of interest.

The afternoon was rounded off with a trip on the miniature railway from Ravenglass to Dalegarth, the open carriages being admirably suitable for the weather conditions which favoured the excursion.

Lunch and dinner were taken on the special train, and the arrangements functioned very well indeed, for the enjoyment of all and to the well-merited satisfaction of the Honorary Secretary, Mr. S. Towill. E. W. A.

SOUTHERN CENTRE

The annual outing for members of the Southern Centre and their wives and friends took place on the 3rd July, when coach parties from Brighton, Portsmouth and Bournemouth, together with members from the Southampton area, met for lunch at the Grand Hotel, Lyndhurst, in the heart of the New Forest. After lunch the whole party of approximately 100 persons visited Southampton docks, and a conducted tour was made of many items of interest, by courtesy of the British Transport Commission, under the able guidance of members of the Publicity Department.

Halt for morning coffee

Some of the Southern Centre party at the 'Potter's Heron', Ampfield.

The tour started with an inspection of the Ocean Terminal where the liner *Queen Elizabeth* was at the quay. The party then proceeded by coach to the new docks in time to see the berthing of the liner *United States* on her arrival from America. The ladies in the party spent much time speculating on the possible sighting of film stars. Tea was taken in the docks canteen, and the party afterwards visited the graving dock at the head of Southampton Water, where members and a few ladies were conducted over the pumping station by Mr. S. C. Clarke, of the British Transport Commission. The party then boarded a pleasure steamer at Southampton pier, and proceeded down Southampton Water past the *Queen Elizabeth* and into the River Itchen before returning. During this section of the trip, the arrival of another liner—the Dutch *Nieuw Amsterdam* was witnessed. The steamship *John Biscoe* was observed tucked away in one of the dock berths, looking very forlorn after her recent fame as a supply vessel for the Antarctic expedition.

The party returned to their respective coaches at about eight o'clock, and so to their various home destinations. The weather throughout the day was very sunny and warm, and many expressions of enjoyment were heard on the excellent outing. The Centre's thanks are particularly due to Mr. E. A. Oscroft of the British Transport Commission for his share of the arrangements, and to Mr. C. G. Brammer, Honorary Social Secretary, for the detailed organization. H. H. C.

WEST WALES (SWANSEA) SUB-CENTRE

The Sub-Centre held its Summer Meeting on the 14th June in Bristol. In the morning a visit was made to the Bristol Aeroplane Co. at Filton. The test department was first inspected, a notable feature of which was the soundproofing of the test cells. After coffee the party proceeded to the *Britannia* assembly shops located in the hangars built originally for the *Brabazon* project. Whilst the aircraft themselves attracted much attention, members were impressed by the constructional features of the vast hangars and the excellent lighting. Trailing cables were reduced to a minimum by the large number of plug points from the under-floor ducting, each point having available a 110-volt d.c. supply for portable tools, a 415-volt 3-phase supply, and compressed air.

Later the party was entertained to lunch by the executives who had been so helpful during the tour. Mr. A. Williams, Power Distribution Engineer of the Bristol Aeroplane Co and a member of The Institution, described briefly how the company bought energy in bulk from the South Western Electricity Board and distributed it to the subsidiary companies, thus effecting an economy in maximum-demand charges. Reference was made to the company's own generating equipment, installed primarily for peak-chopping purposes. Even so, test loads provided a problem. Mr. J. Greenwood, also a member of The Institution, replied very ably to questions raised by the members of the Sub-Centre. Mr. J. L. Griffiths, our Chairman, thanked the company for the excellent arrangements and for the hospitality we had received.

During the afternoon some members visited the new showrooms of the South Western Electricity Board, whilst others spent an hour or so at the Zoo.

Dinner was served at the Duke Hotel, Cowbridge, and this was followed by a convivial evening. R. F. D.

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Hon. Secretary: F. F. FREELING, Midlands Electricity Board, Bowling Hill, Chipping Sodbury, Bristol.

Hon. Asst. Secretary (Bristol): W. D. MORGAN, W. T. Glover and Co. Ltd., 123 Victoria Street, Bristol, 1.

Hon. Asst. Secretary (Cardiff): D. STEPHENS, 7 Clovelly Crescent, Llanrumney, Cardiff.

Western Supply Group

Chairman: C. W. A. PRIEST, B.SC.(ENG.).

Hon. Secretary: A. A. BECKINGSALE, Central Electricity House, 26 Oakfield Road, Bristol, 8.

Western Utilization Group

Chairman: F. J. BABER.

Hon. Secretary: G. M. HUGHES-CALEY, B.T.H. House, 119 Victoria Street, Bristol, 1.

Hon. Asst. Secretary: W. S. EVANS, Docks Engineer's Office, Port of Bristol Authority, Avonmouth, Bristol.

South-Western Sub-Centre

Chairman: C. H. FOULKES.

Hon. Secretary: G. B. DEVEY, P.O. Engineering Dept., 23 Victoria Park Road, Exeter.

Hon. Asst. Secretary: S. D. CHAPMAN, 'Hycrest', Highbury Crescent, Plympton, Plymouth.

West Wales (Swansea) Sub-Centre

Chairman: I. G. EVANS.

Hon. Secretary: W. E. LEWIS, B.SC., PH.D., 19 Wimmerfield Crescent, Killay, Swansea.

Hon. Asst. Secretary: D. H. HUGHES, 5 Hillside, Furnace, Llanelly, Carmarthenshire.

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Hon. Secretary: L. W. BRAZEL, The Calcutta Electric Supply Corporation Ltd., Victoria House, Calcutta.

CEYLON BRANCH

Chairman: E. C. FERNANDO, M.B.E., B.SC.(ENG.).

Hon. Secretary: M. I. AZIEZ, B.SC., Electrical Engineer, Operations and Maintenance, Dept. of Government Electrical Undertakings, P.O. Box 540, McCallum Road, Colombo, 10.

IRISH BRANCH

Chairman: L. COLLINS, B.E., B.SC.

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Queensland

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Hon. Secretary: W. I. GEORGE, B.E., c/o The English Electric Co. Ltd., P.O. Box 406F, G.P.O., Brisbane.

South Australia

Chairman: Appointment pending.

Hon. Secretary: J. W. CROMPTON, B.E., 139 Fisher Street, Malvern.

Victoria and Tasmania

Chairman: J. WILSON.

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Madras

Chairman: Appointment pending.

Hon. Secretary: R. WRIGHT, M.B.E., 4 Buckingham Gardens, Madras, 12.

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BRAZIL

E. WINSTANLEY, B.SC.(ENG.), The Rio de Janeiro Flour Mills and Granaries Ltd., Caixa Postal 486, Rio de Janeiro.

BURMA

C. H. MELLOR, c/o Rangoon Electric Supply Board, 503/9 Merchant Street, Rangoon.

CANADA

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CAPE PROVINCE

C. G. DOWNIE, B.SC., c/o City Electricity Dept., P.O. Box 82, Cape Town.

CEYLON

J. G. PARK, Office of the United Kingdom High Commissioner, 7 Prince Street, Colombo.

EAST AFRICA

A. O. COSGROVE, B.SC., The General Electric Co. Ltd., P.O. Box 5100, Nairobi.

FAR EAST

D. S. HILL, Reiss, Bradley and Co. Ltd., National City Bank of New York Building, 2 Queens Road C, Hong Kong.

FRANCE

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Deputy Representative: R. A. TELLIER, ING.E.S.E., c/o Électricité de France, 12 Place des États-Unis, Paris (16e).

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Deputy Representative: L. W. BRAZEL, c/o Calcutta Electric Supply Corporation, Calcutta.

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MIDDLE EAST

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Deputy Representative: H. D. FURBER, The Iraq Petroleum Co. Ltd., Electrical Engineering Dept., P.O. Box 150, Tripoli, Lebanon.

NEW SOUTH WALES

Appointment pending.

NEW ZEALAND

E. H. R. GREEN, C.B.E., M.SC., Engineer-in-Chief, General Post Office, Wellington, C.1.

PAKISTAN

K. I. BROWN, M.B.E., c/o Associated Electrical Industries (Pakistan) Ltd., Shernaz House, West Wharf Road, Post Box 4958, Karachi, Pakistan.

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SWITZERLAND

L. W. HAYES, O.B.E., 43 Quai Wilson, Geneva.

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Deputy Representative for Tasmania: H. P. TUCK, M.E., B.SC., Associate Professor, University of Tasmania, Hobart, Tasmania.

WEST AFRICA

J. HOUSTON ANGUS, P.O. Box 388, Lagos, Nigeria.

WEST INDIES

H. D. WALDEN, B.SC., c/o The Trinidad Oil Co. Ltd., 19 La Carriere Road, Point-a-Pierre, Trinidad.

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During the period 1st July to 15th September the following members called at the Institution building and signed the Attendance Register of Oversea Members:

ADDISON, J. D., M.B.E. (Kuwait)
APSIMON, W. I. (Sierra Leone)
ASCOUGH, H. L. N. (Bridgetown)
BEAN, L. P. R. (Sydney)
BIRCH, R. G. (Salisbury, S. Australia)
BRAZEL, L. W. (Calcutta)
BROWN, K. I., M.B.E. (Pakistan)
BROWN, T. A. (Cape Province)
CLARE, L. J. (Toronto)
COHEN, J. H. L. (Salisbury, S. Australia)
FRANCO, V. (Entebbe)
FREELAND, M. M. (Singapore)
GEARE, H. W. (Cape Town)
GIBSON, A. E. C. (Karachi)
GLASSON, L. W. A. (Adelaide)
GUPTA, S. L. (New Delhi)
HALL, A. J. C. (Melbourne)
HARDY, F. E. M. (Abadan)
HARLAND, D. J. S. (Kuala Lumpur)
HENRIQUES-PINHEIRO, J. (Lisbon)
HOLLEY, R. J. (Lucknow)
HORGAN, M. J. (Cape Town)
HUMPHREYS, K. A. (Accra)
JOHNSTON, C. G. (Bridgetown)
KATER, G. B., M.A. (Sydney, Australia)
KING, J. A. C. (Kuwait)
LABROOY, C. H. J. (Ipoh, Malaya)
MATTHEWS, H. (Kuwait)
MAYLIN, R. F. (Abeokuta, Nigeria)
MELLOR, C. H. (Rangoon)
MYERS, A. J. (Ghana)
NICHOLLS, M. R. (Wellington, New Zealand)
REDSHAW, D. C. (Mombasa)
REID, J. E. (Calcutta)
RITCHIE, D. L., B.SC. (Johannesburg)
ROSEVEARE, S. (Toronto)
SALAM, M. A. (Baghdad)
SANKEY, R. G. (Port of Spain)
SHAWEESH, H. M. (Amman)
SIRAJUDDIN, A. W. (Lahore)
STEWART, C. E. (Bombay)
STIRRUP, H. (Kadura, N. Nigeria)
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SUTTENWORTH, E. W. (Wellington, New Zealand)
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WOOLNOUGH, G. L. (New South Wales)
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